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(54) **BONE RESURFACING SYSTEM AND METHOD**

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This patent is subject to a terminal disclaimer.

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USPC .... 606/79, 80, 86 R, 87–89, 90, 96, 97, 606/102, 104; 623/20.14
See application file for complete search history.

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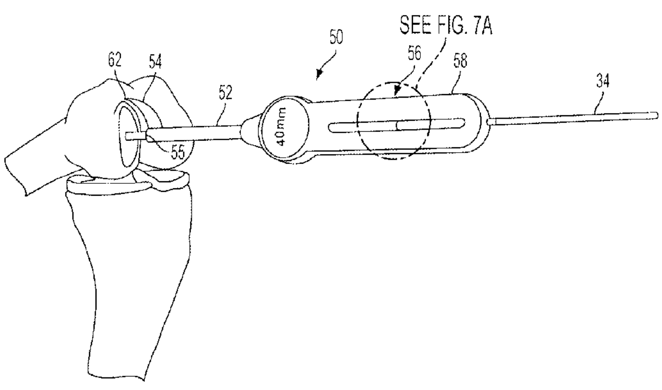
(57) **ABSTRACT**

The present disclosure relates to bone resurfacing. One embodiment includes a method for preparing an implant site in bone, comprising establishing a first working axis extending from said bone; establishing a second working axis extending from said bone, the second working axis is displaced from the first working axis; creating a first socket in the bone by reaming about the first working axis; and creating a second socket in the bone, adjacent the first socket, by reaming about the second working axis.

20 Claims, 39 Drawing Sheets



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a continuation-in-part of application No. 11/359,891, filed on Feb. 22, 2006, now Pat. No. 7,713,305, which is a continuation-in-part of application No. 10/373,463, filed on Feb. 24, 2003, now Pat. No. 7,678,151, which is a continuation-in-part of application No. 10/162,533, filed on Jun. 4, 2002, now Pat. No. 6,679,917, which is a continuation-in-part of application No. 10/024,077, filed on Dec. 17, 2001, now Pat. No. 6,610,067, which is a continuation-in-part of application No. 09/846,657, filed on May 1, 2001, now Pat. No. 6,520,964, said application No. 12/397,095 is a continuation-in-part of application No. 11/169,326, filed on Jun. 28, 2005, now Pat. No. 8,361,159, which is a continuation-in-part of application No. 10/994,453, filed on Nov. 22, 2004, now Pat. No. 7,896,885, which is a continuation-in-part of application No. 10/308,718, filed on Dec. 3, 2002, now Pat. No. 7,163,541.

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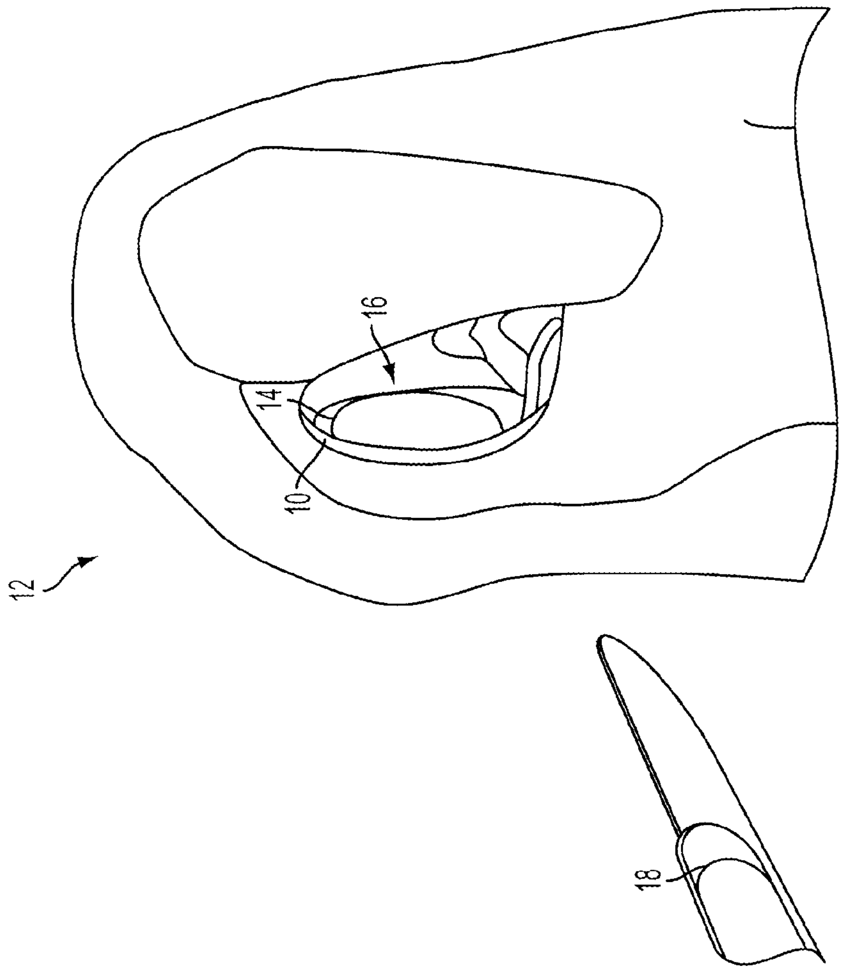


FIG. 1

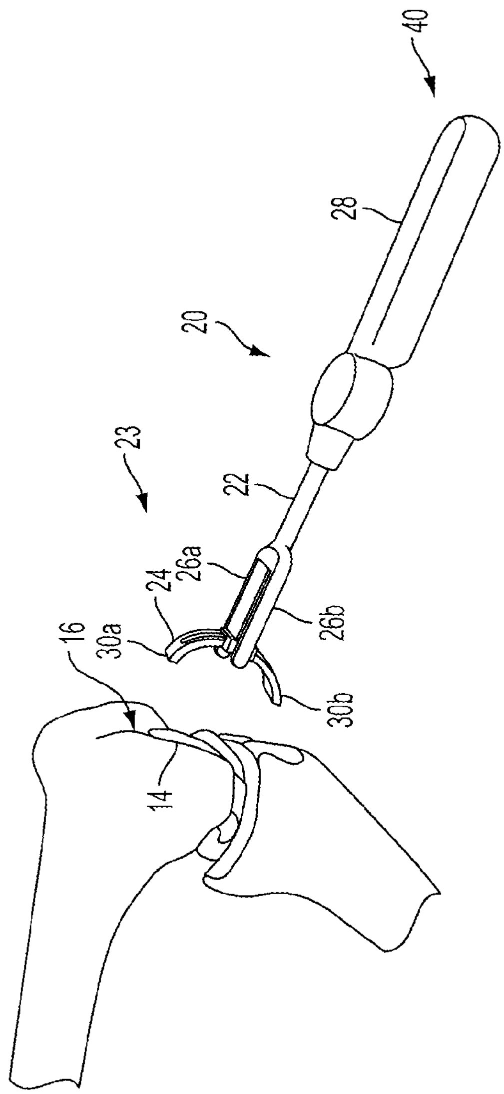
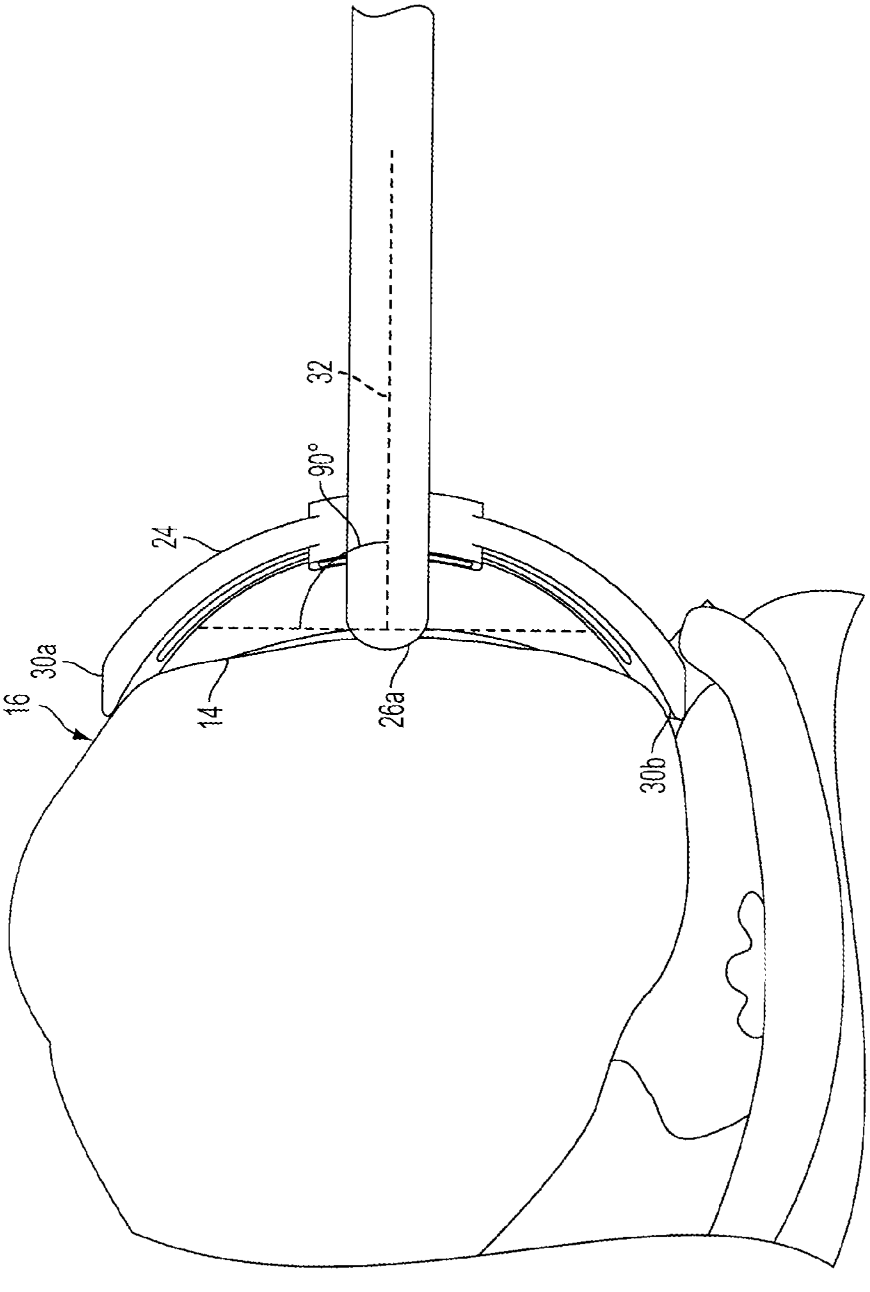


FIG. 2



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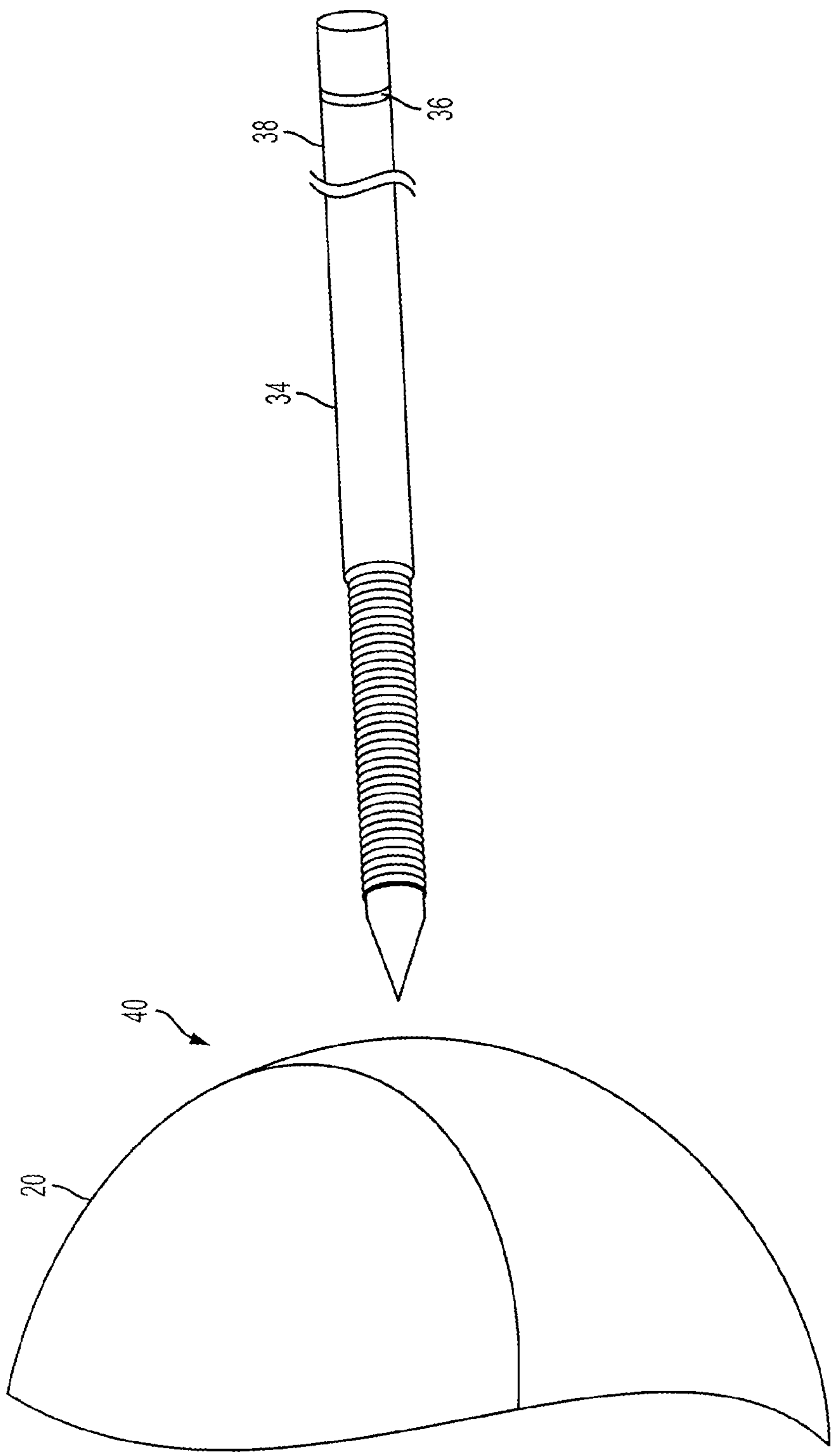

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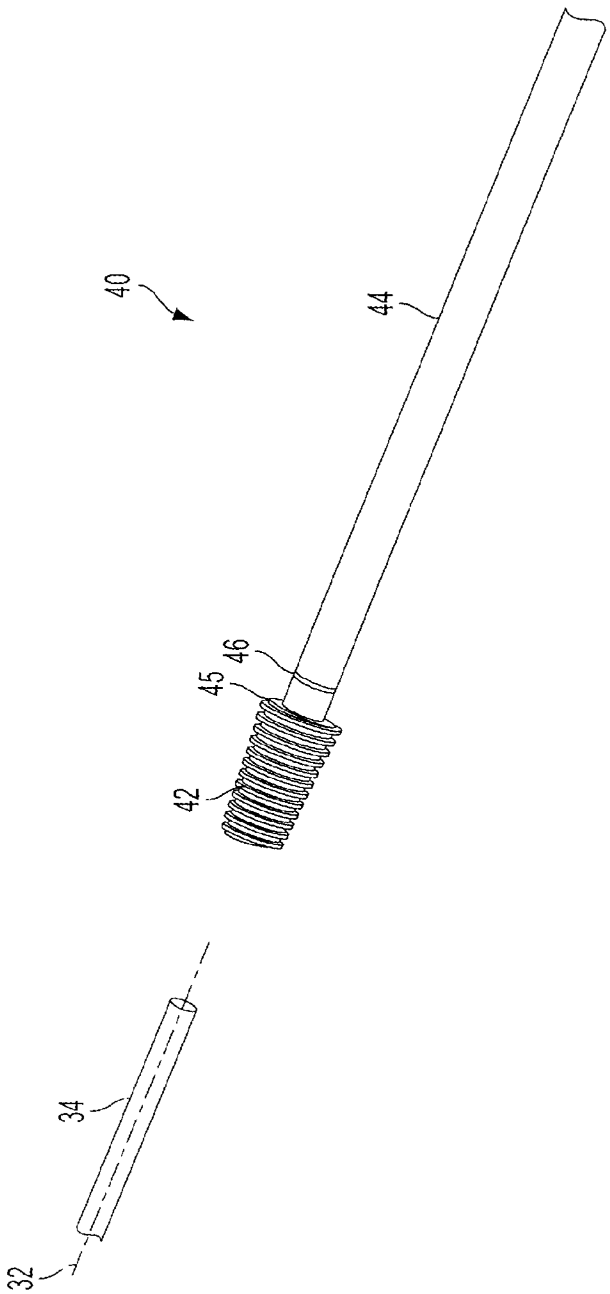


FIG. 5

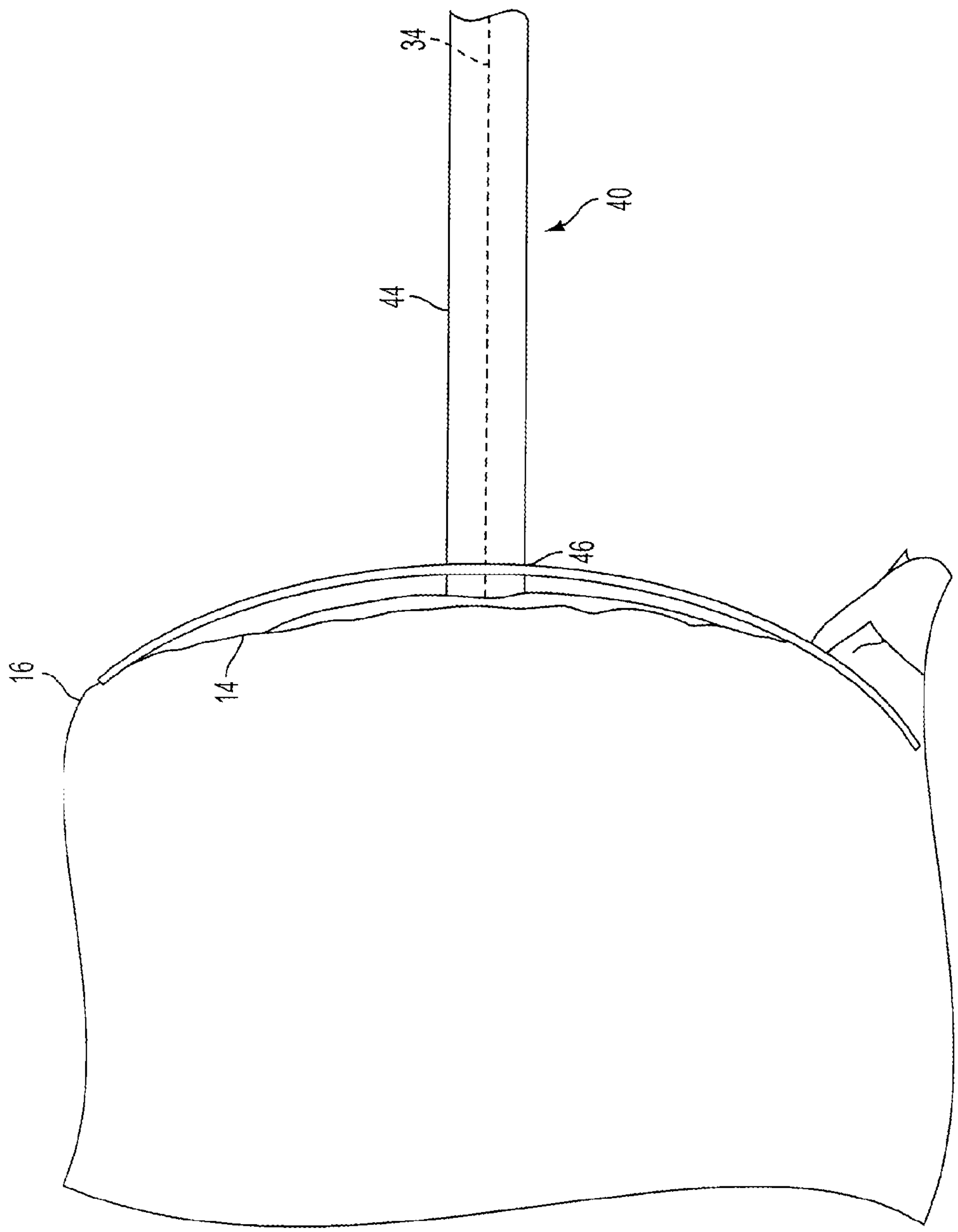
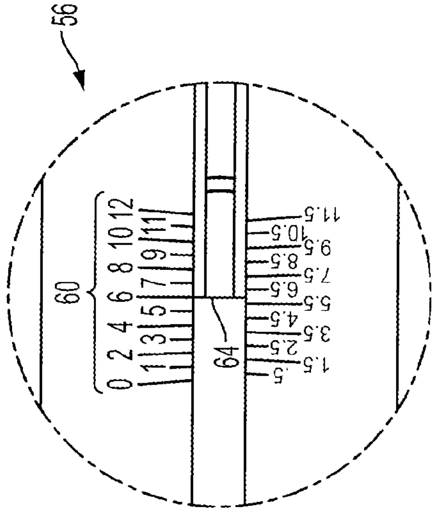


FIG. 6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60
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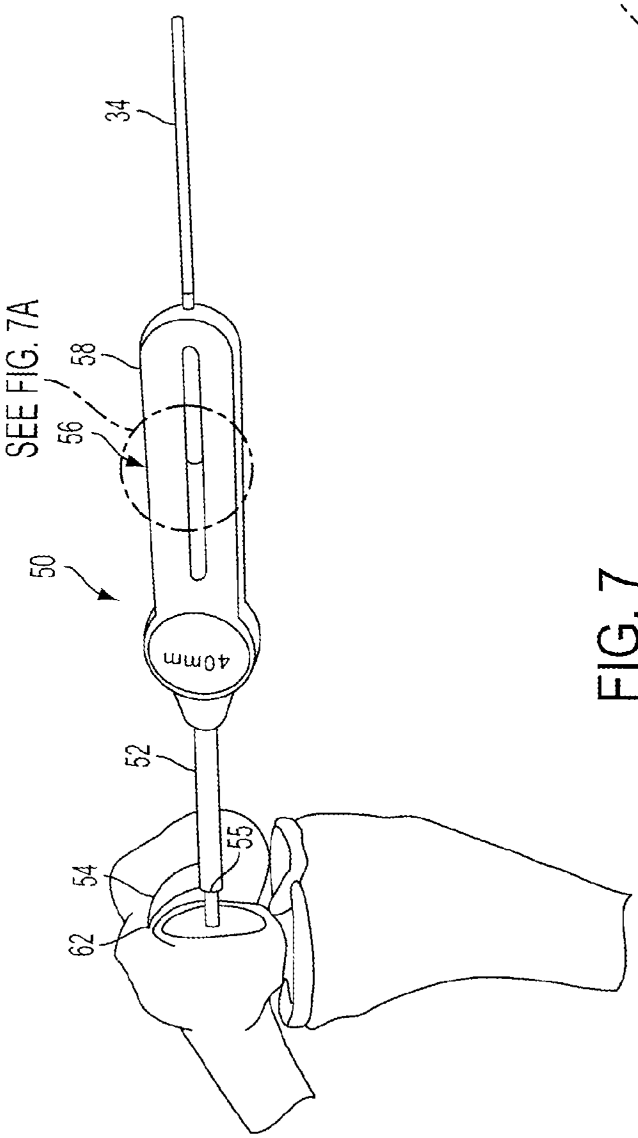
64

FIG. 7A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SEE FIG. 7A
58
56
50
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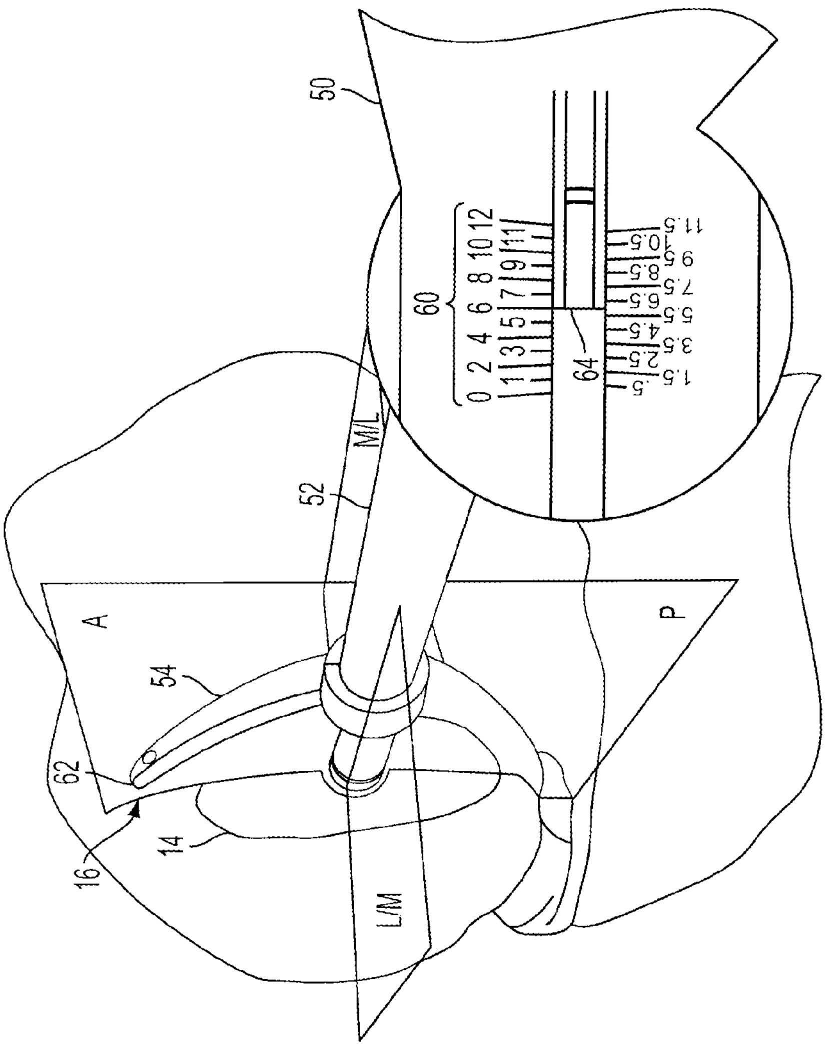
62

FIG. 7



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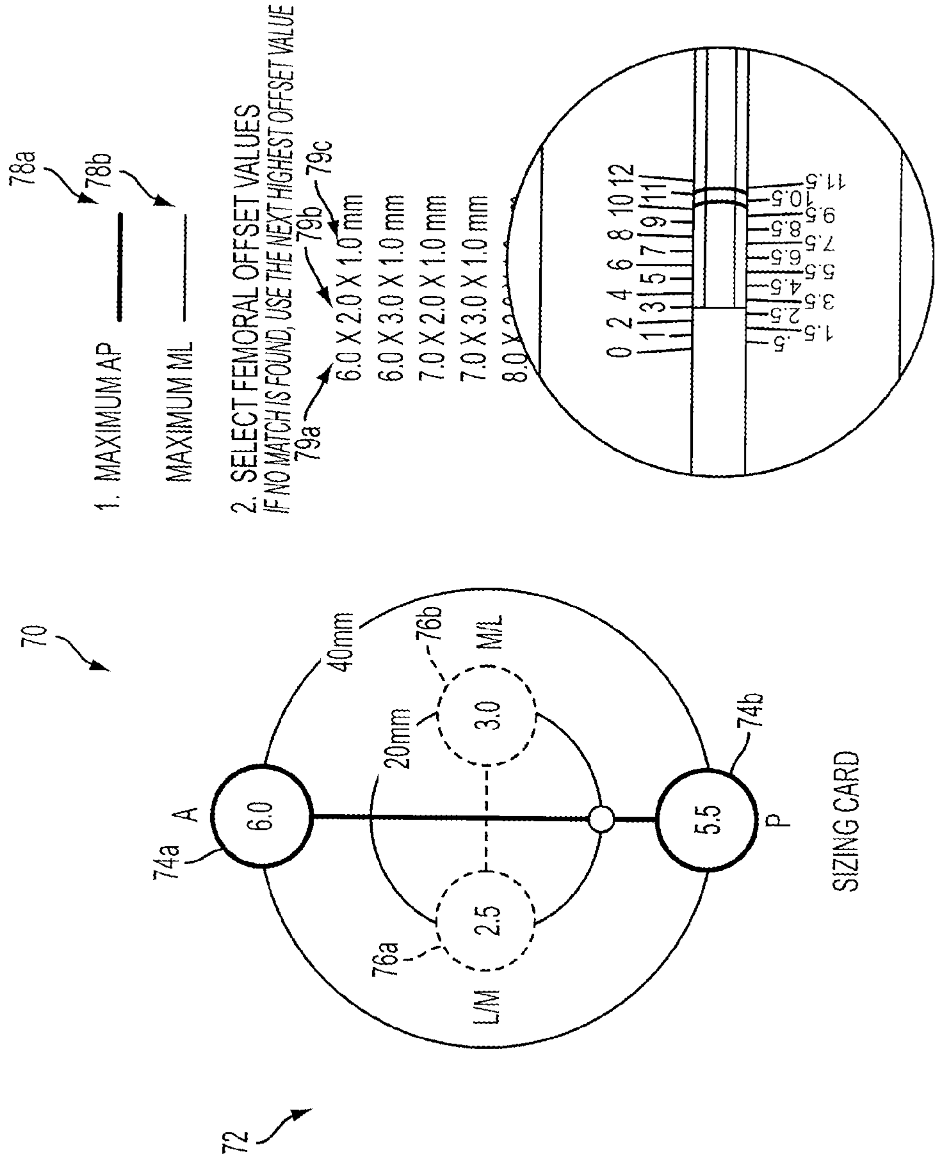
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MAXIMUM ML
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6.0 X 3.0 X 1.0 mm
7.0 X 2.0 X 1.0 mm
7.0 X 3.0 X 1.0 mm
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78b
79a
79b
79c
70
72
74a
74b
76a
76b
A
P
L/M
M/L
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5.5
2.5
3.0
20mm
40mm
SIZING CARD

FIG. 9

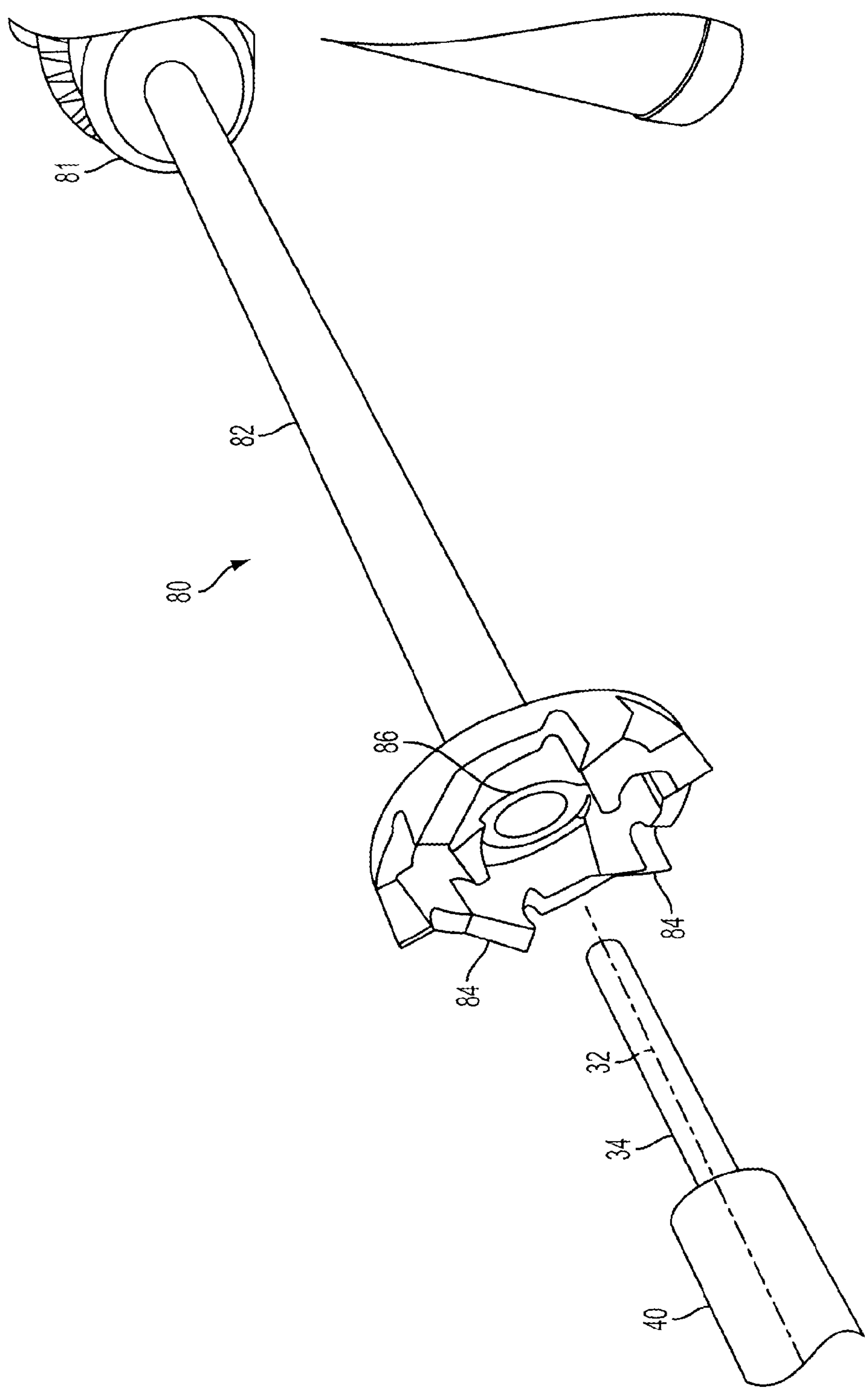


FIG. 10

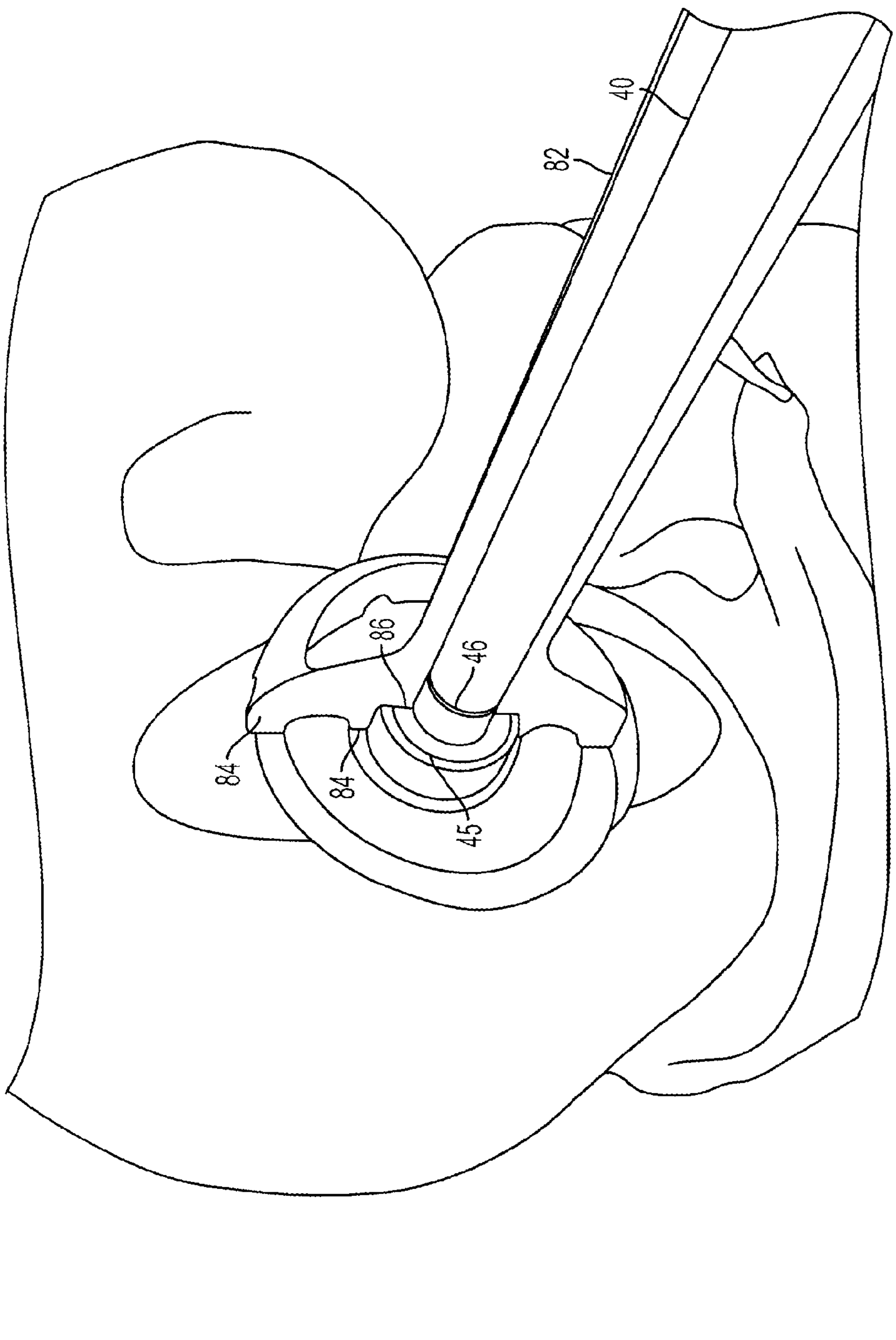


FIG. 11

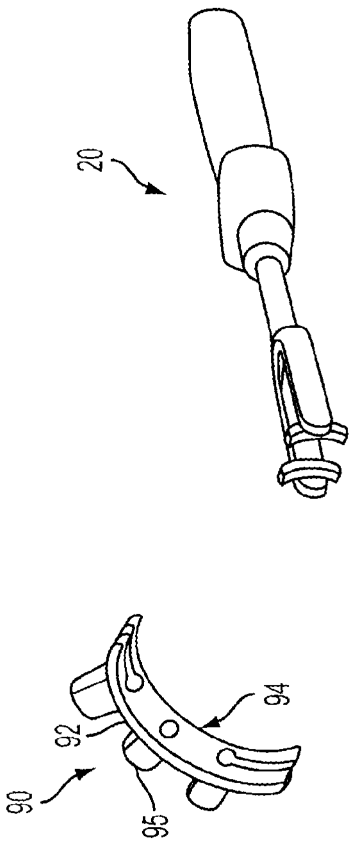


FIG. 12

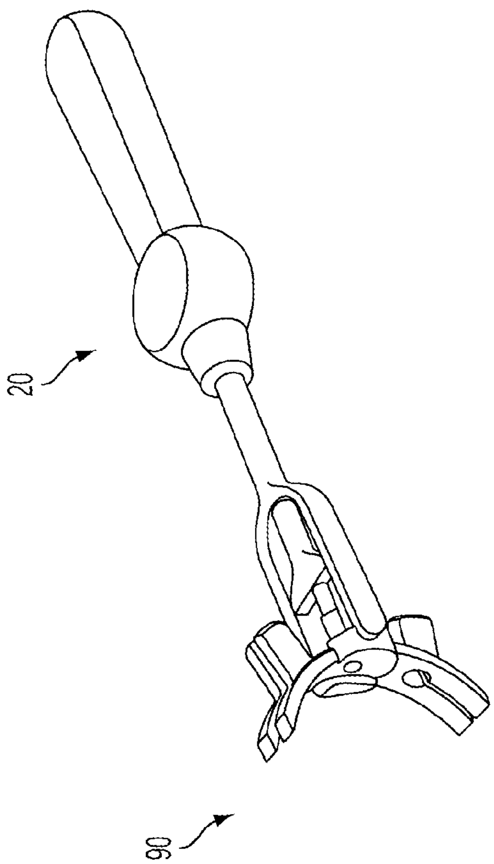


FIG. 13

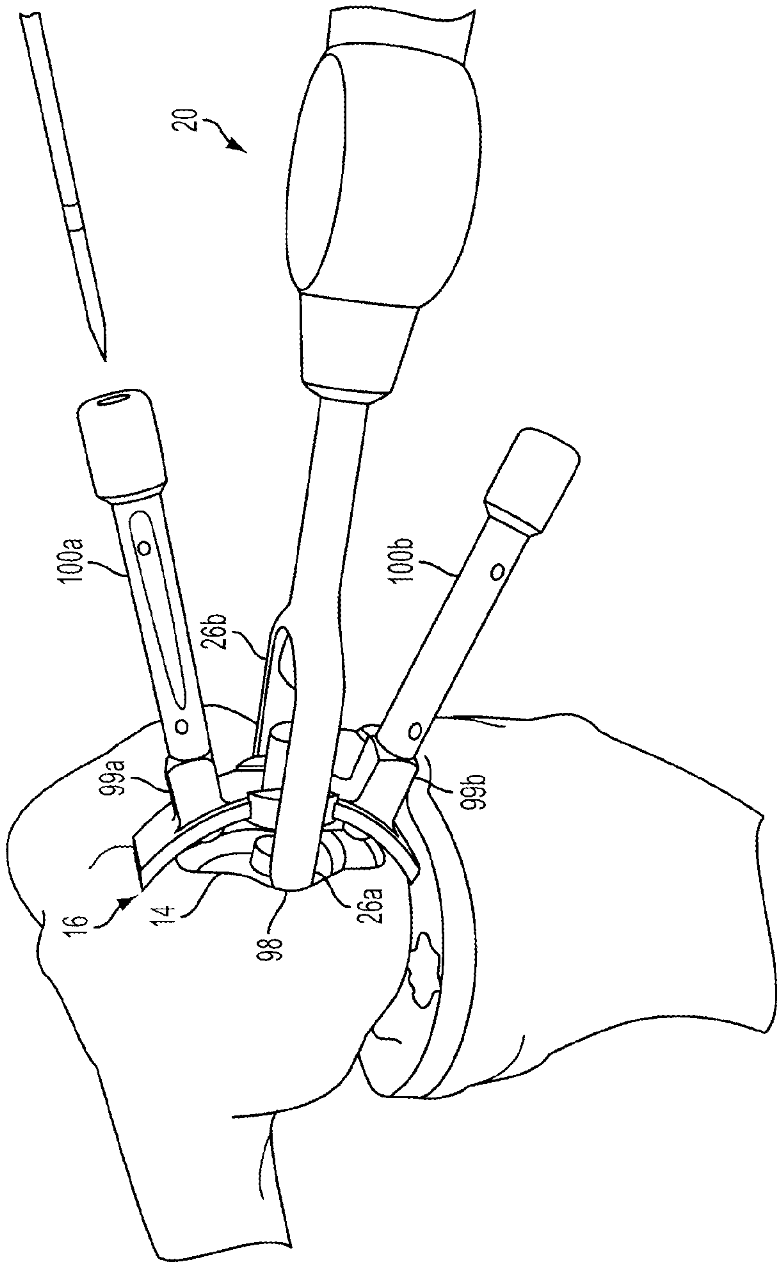


FIG. 14

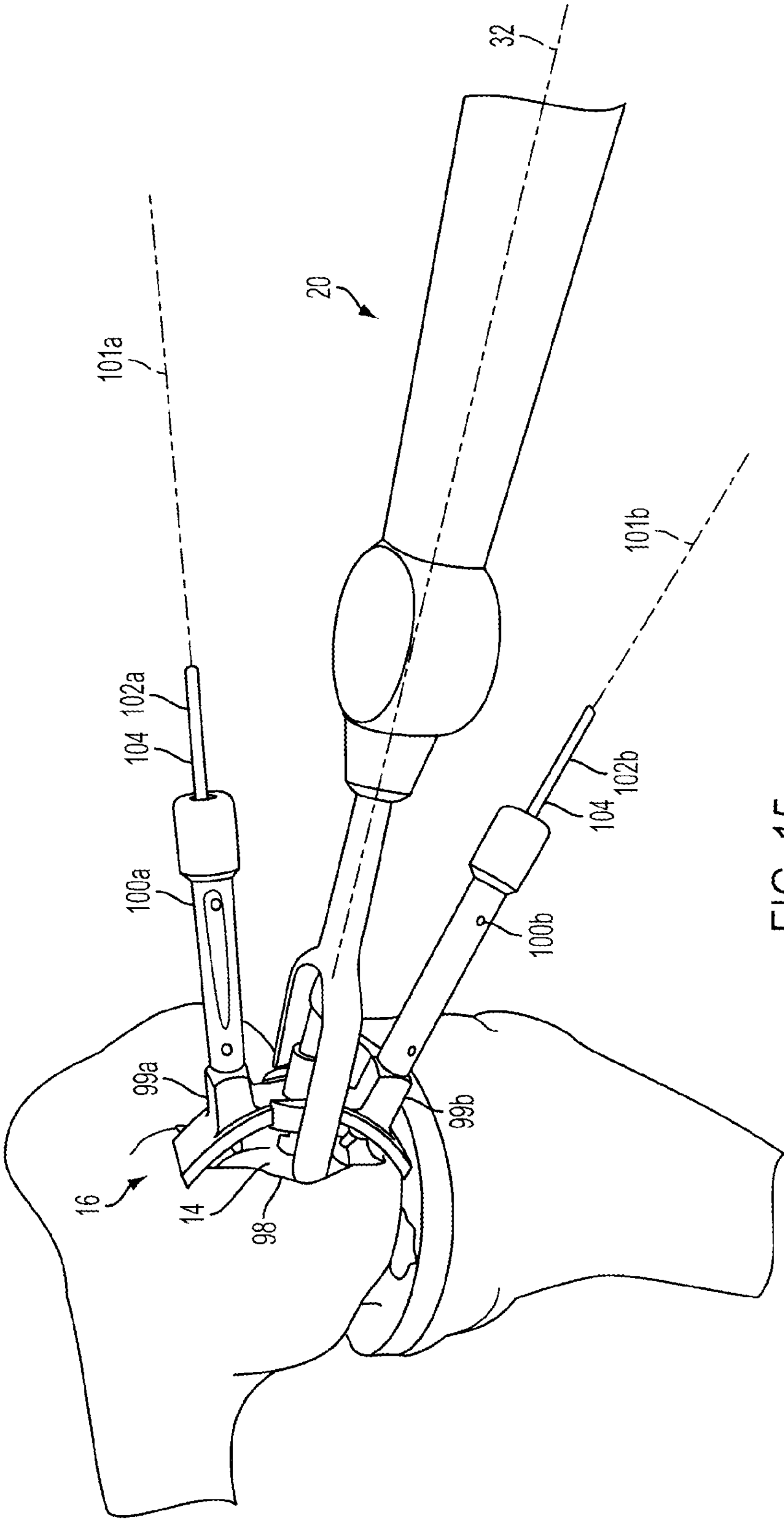


FIG. 15

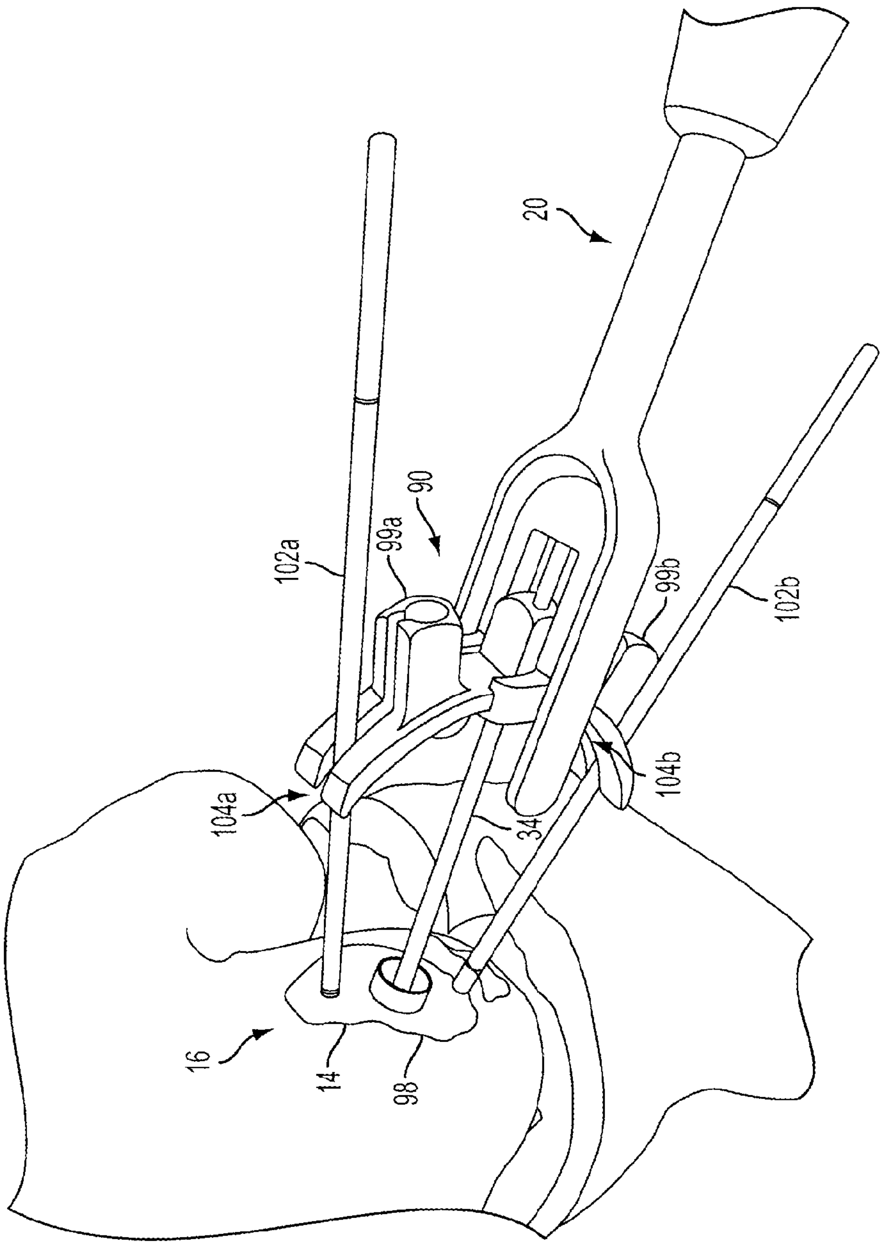


FIG. 16

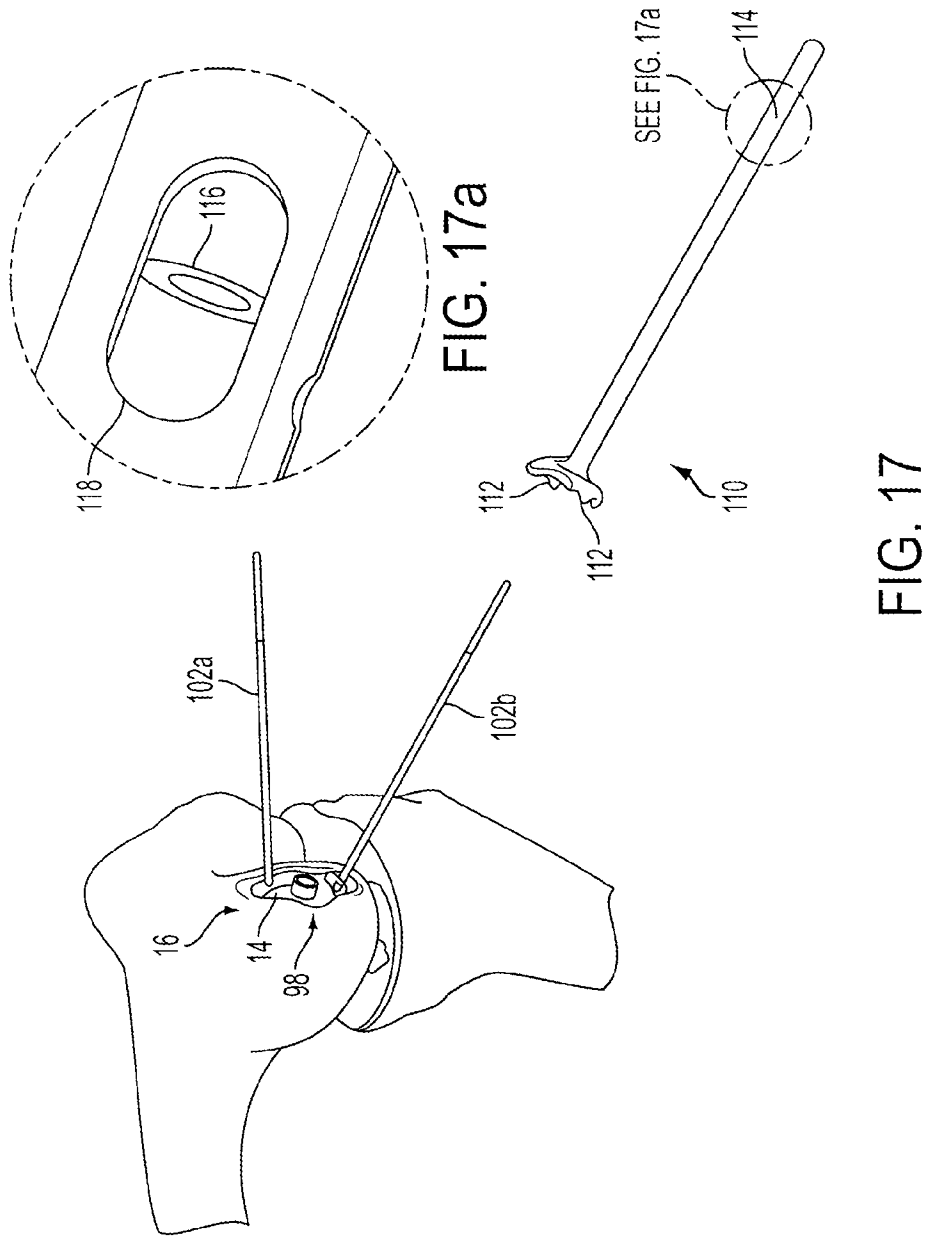


FIG. 17a

FIG. 17

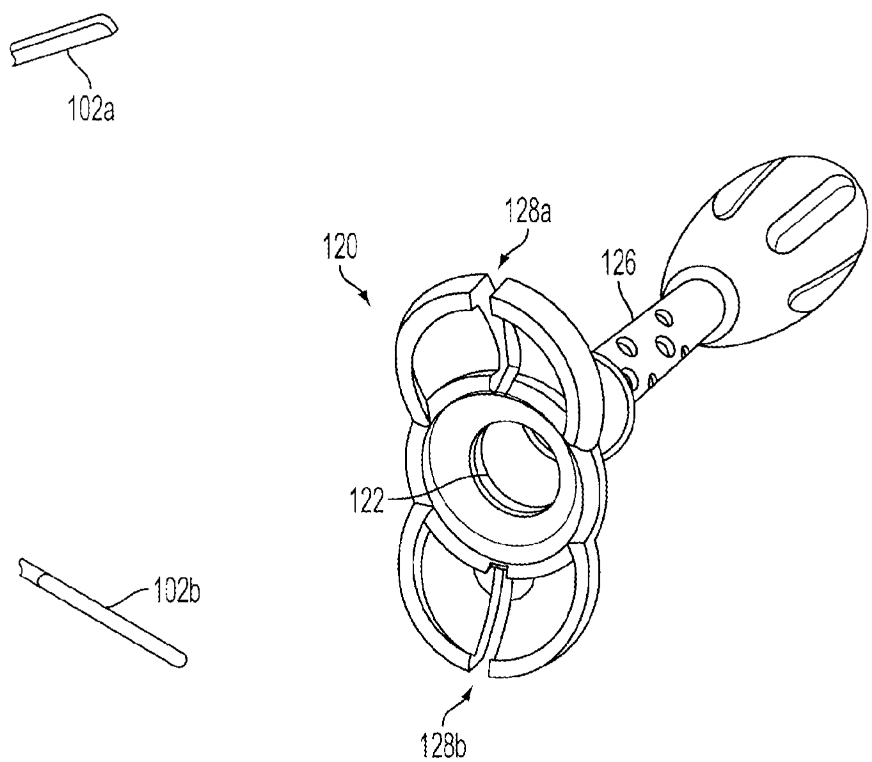


FIG. 18

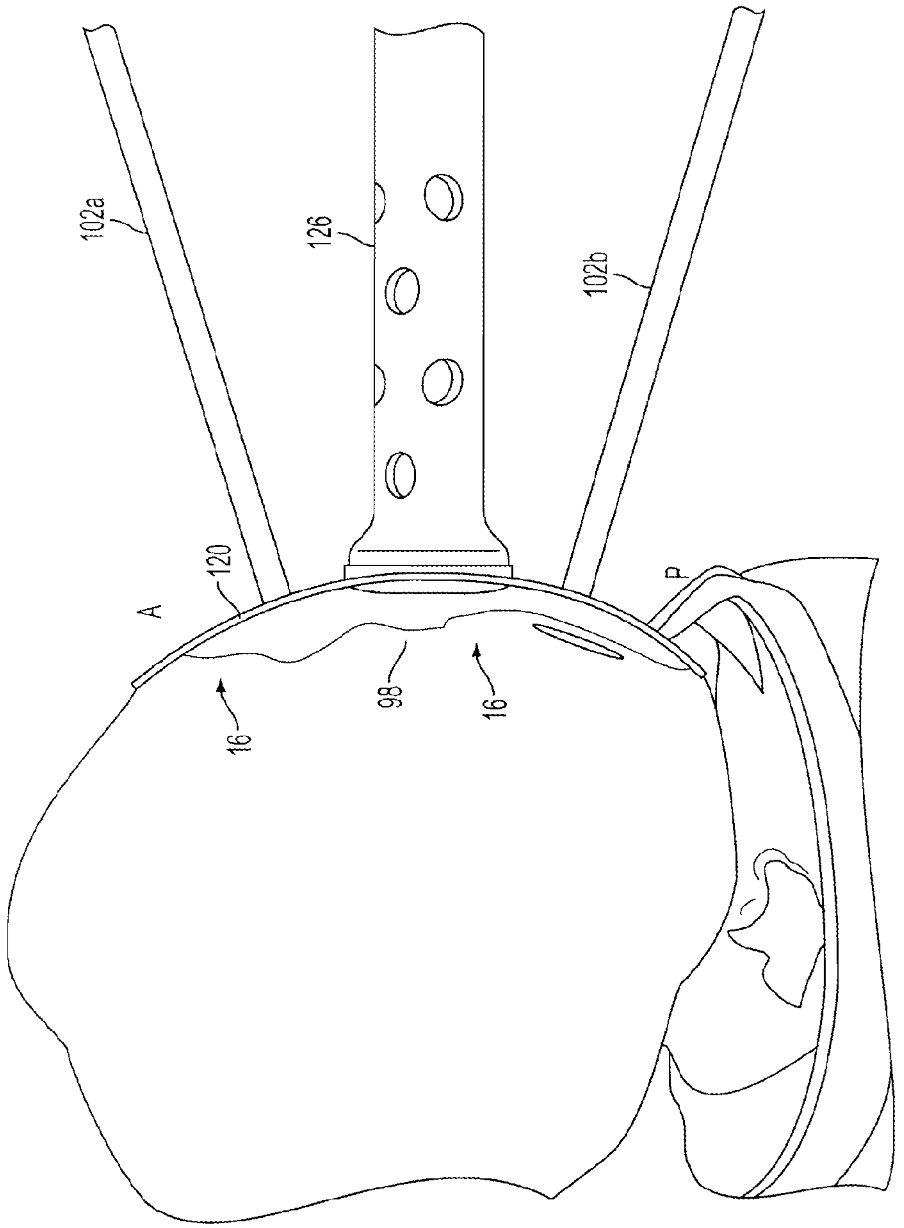


FIG. 19

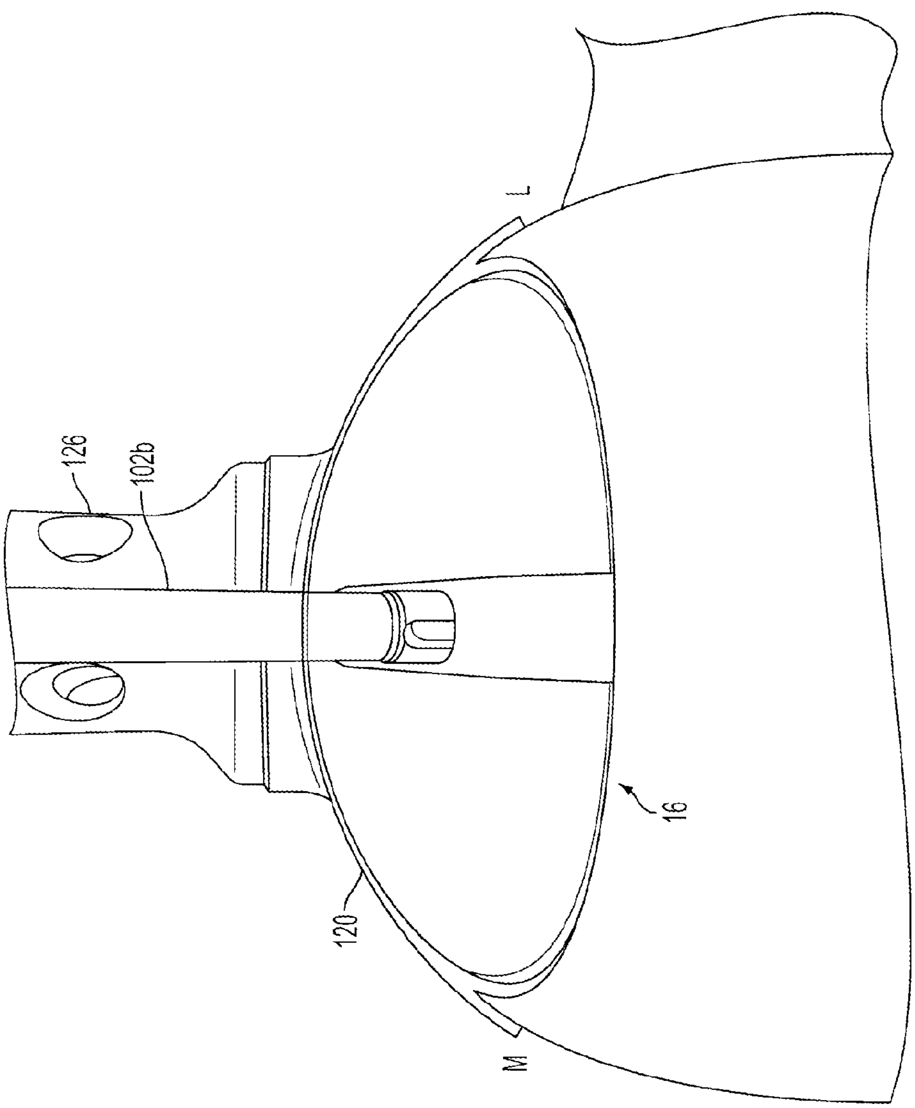
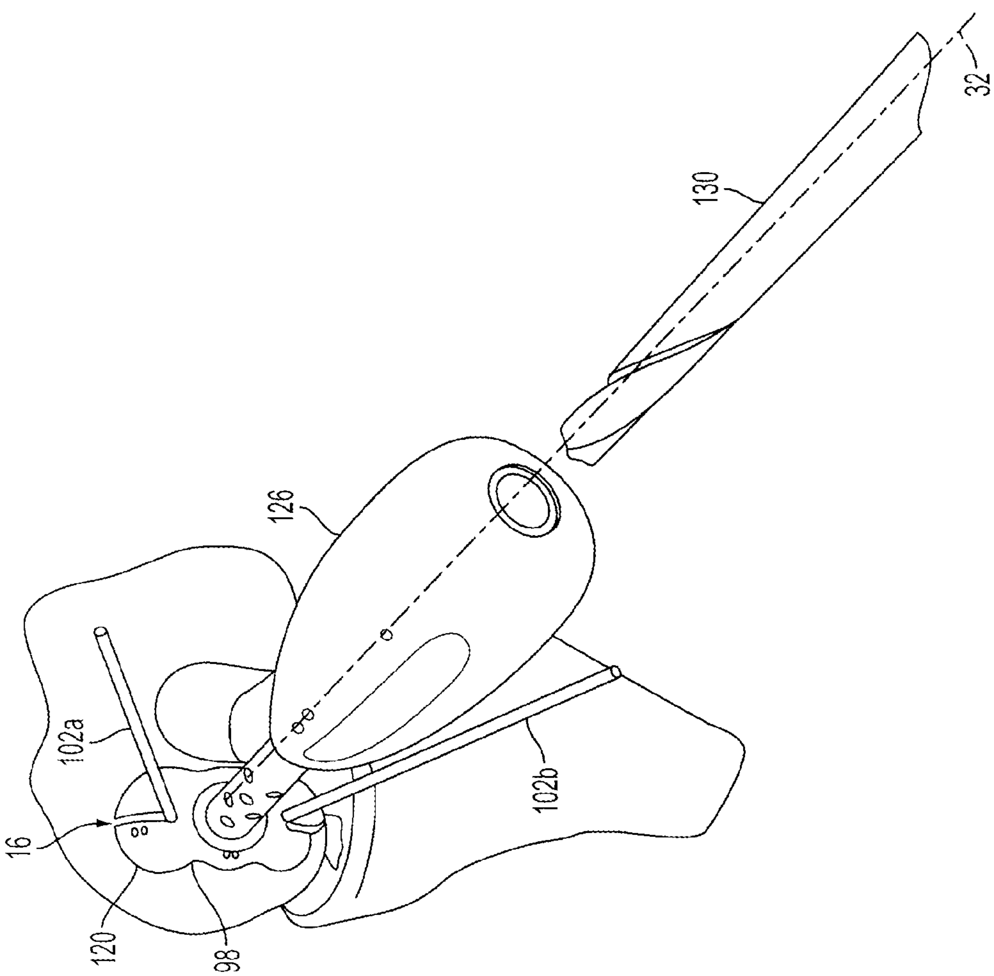


FIG. 20



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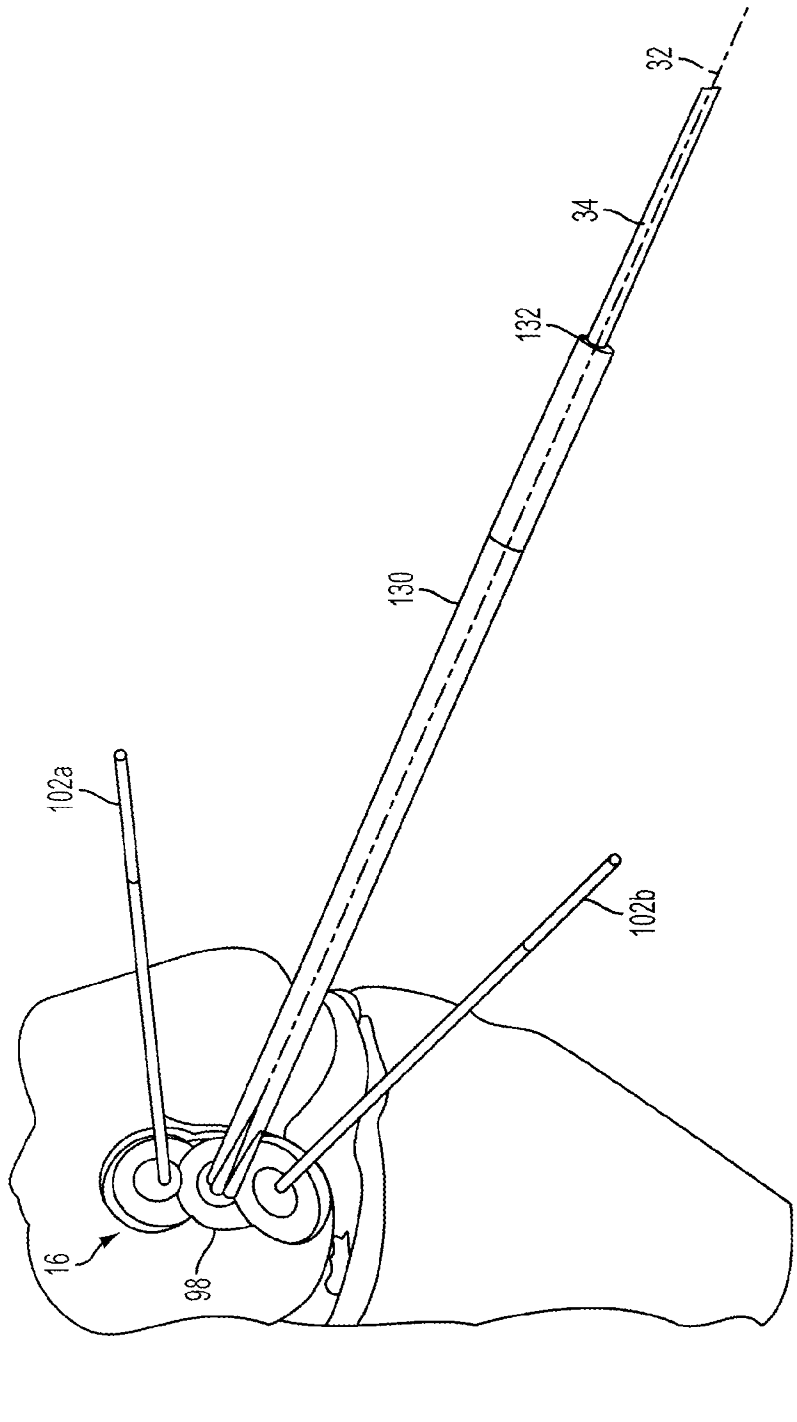

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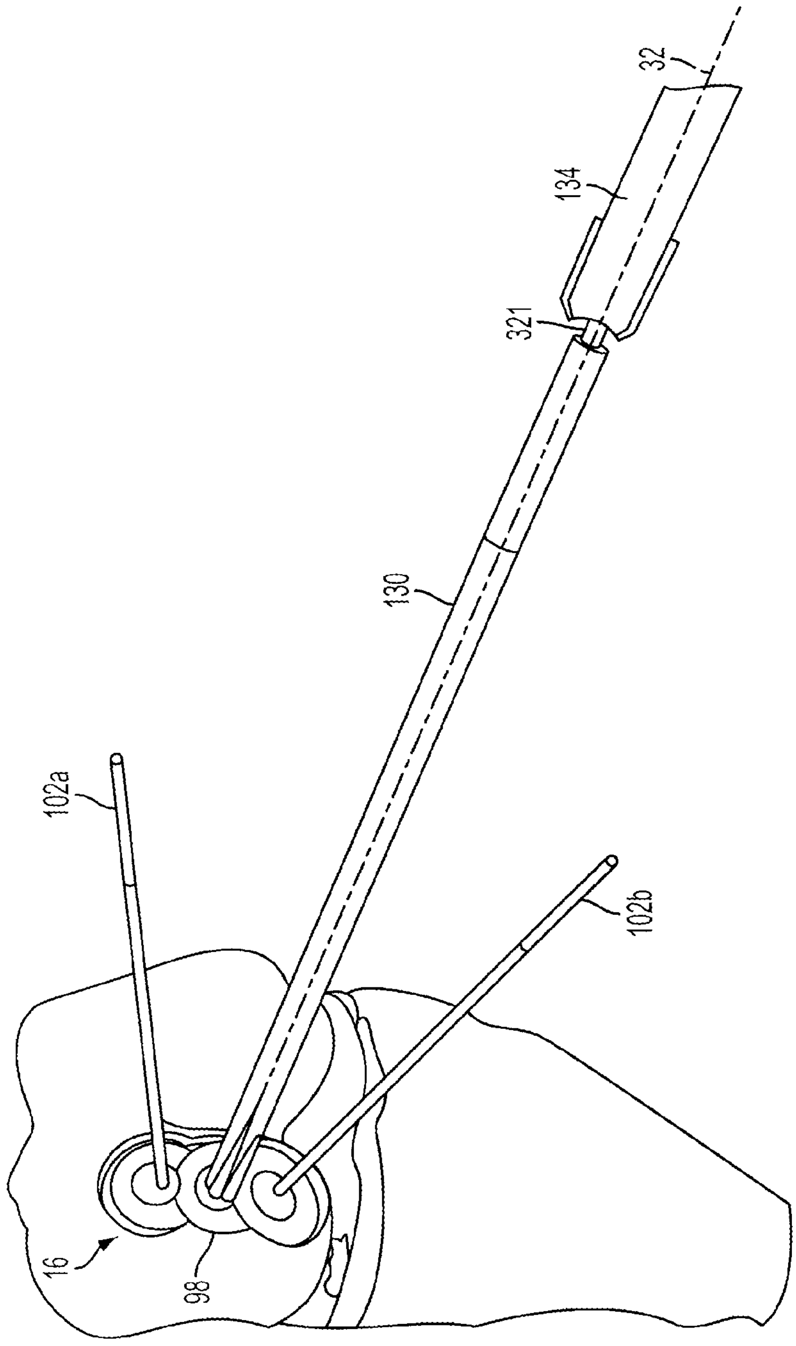


FIG. 23

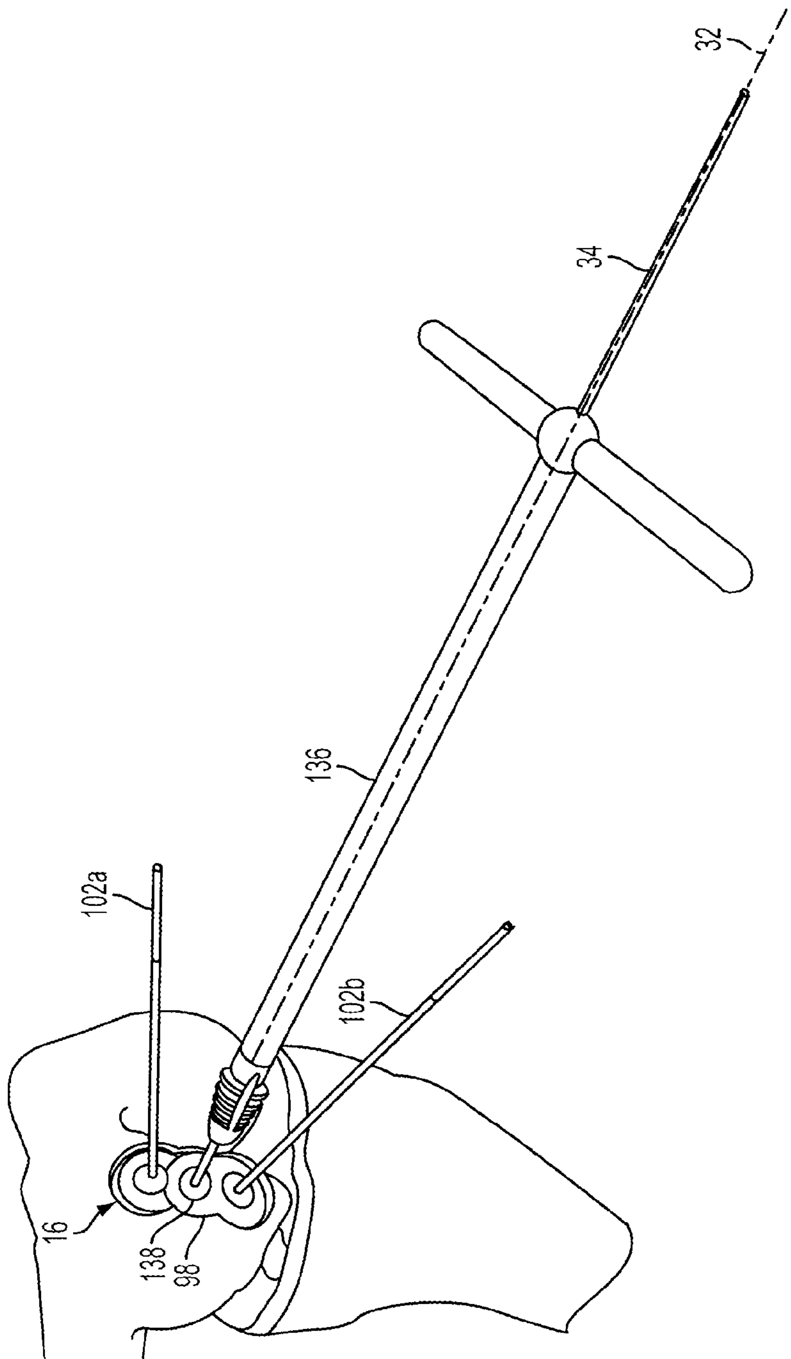
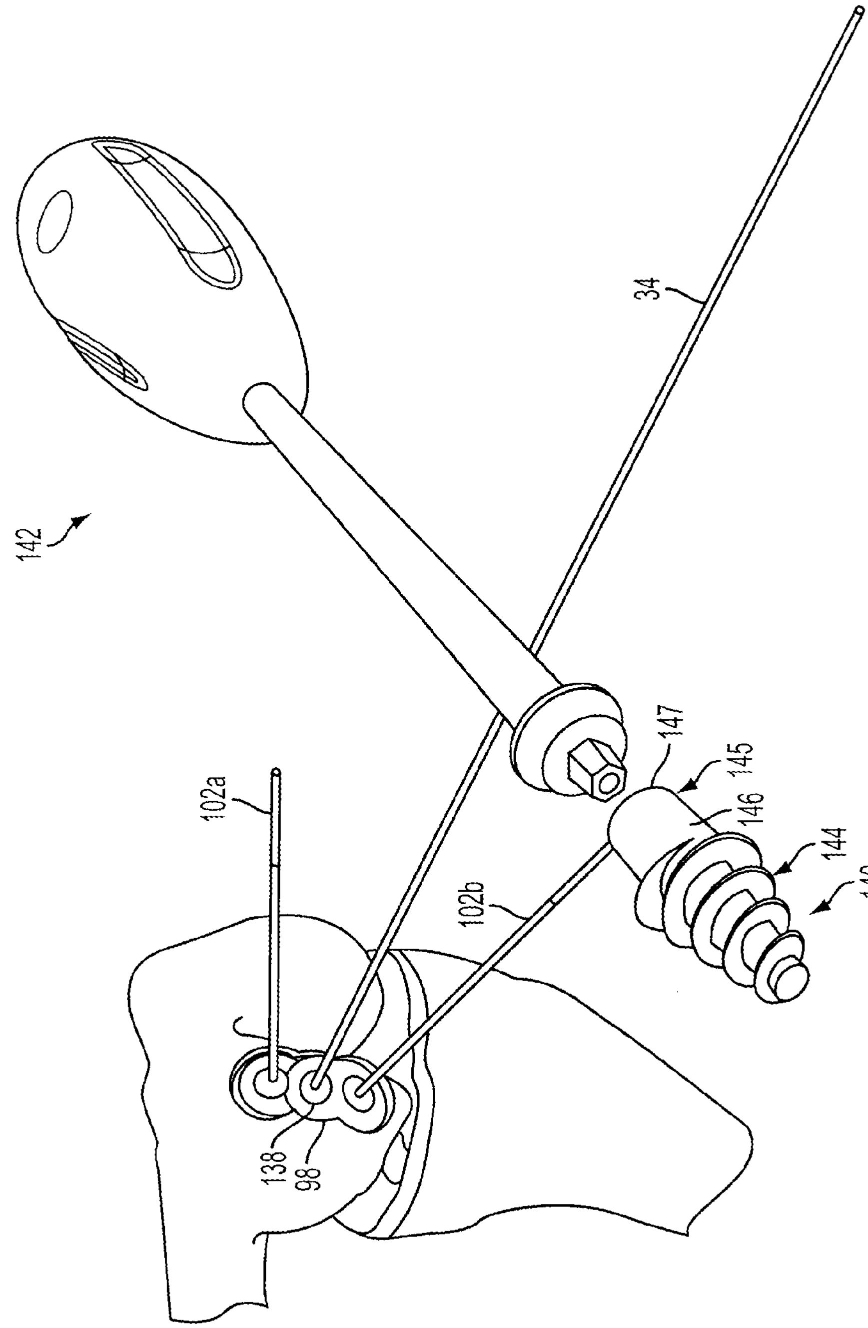


FIG. 24



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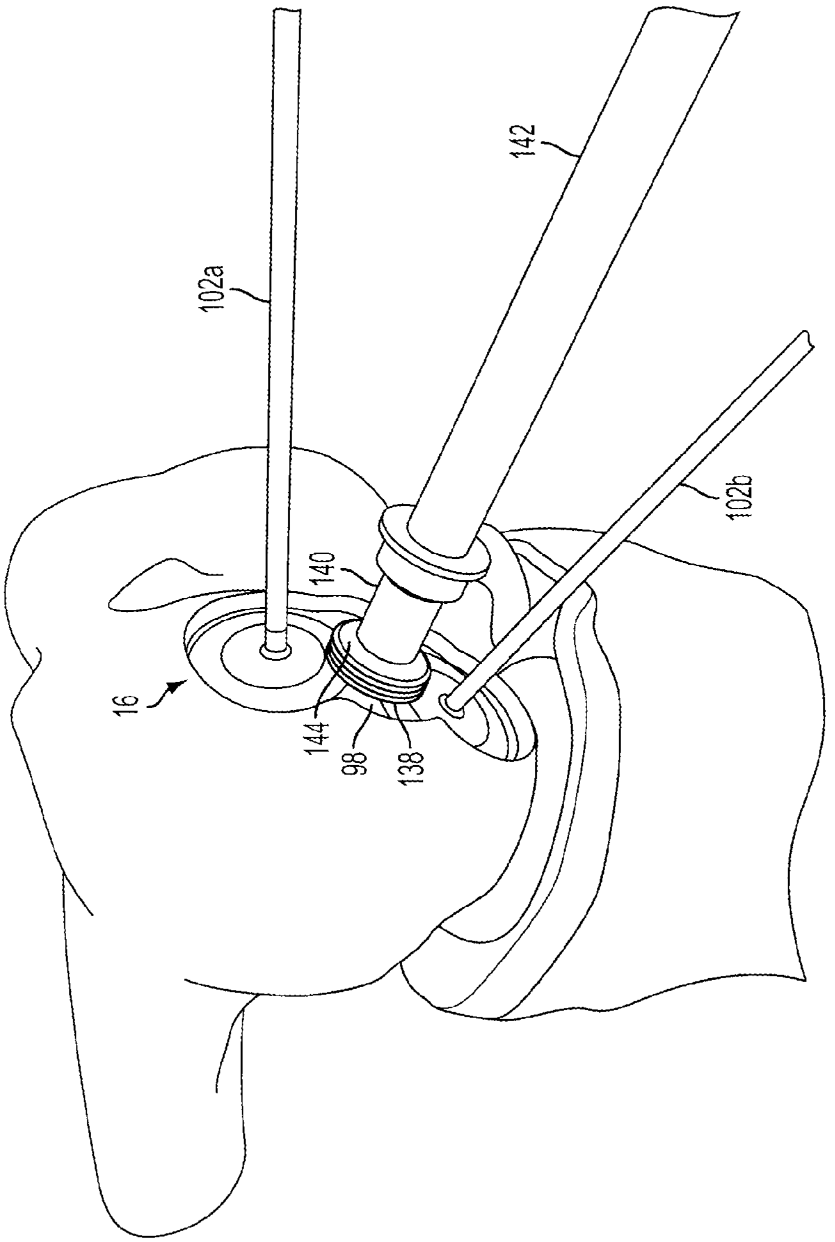

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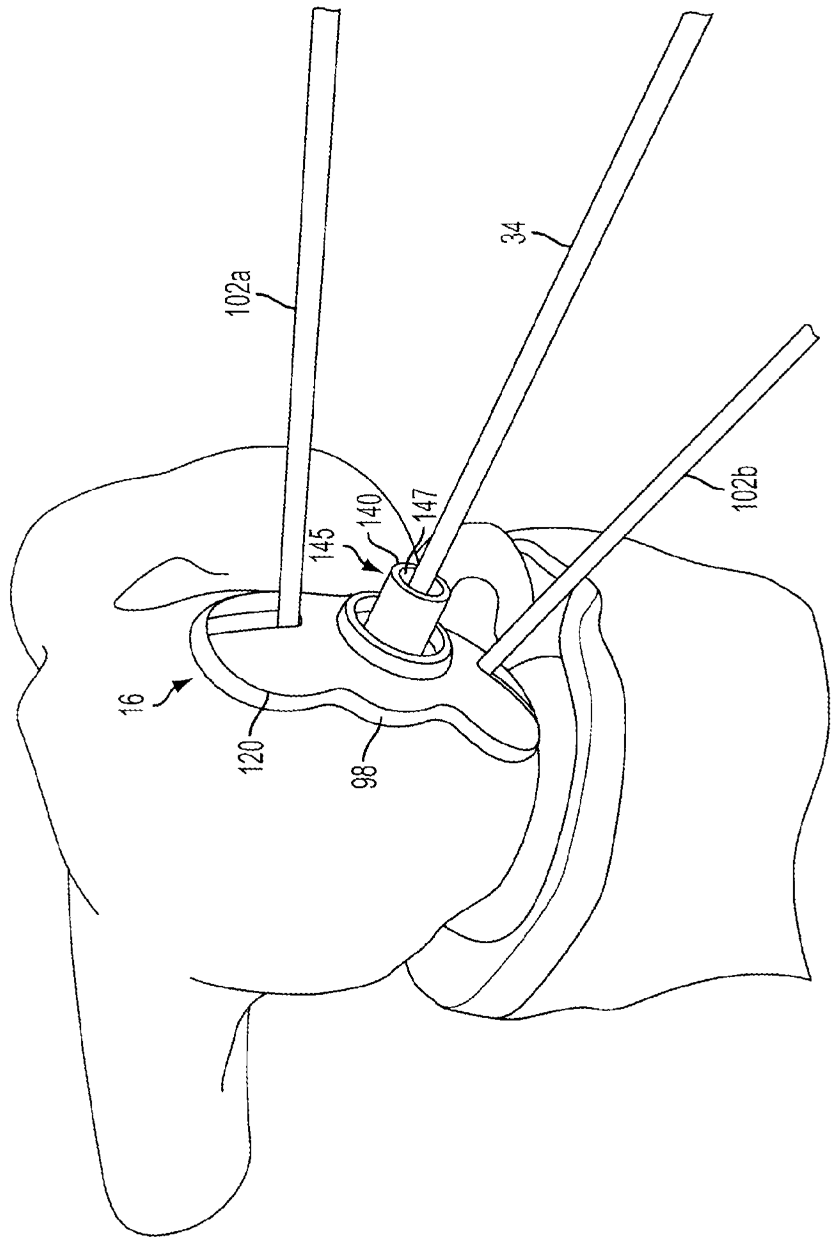

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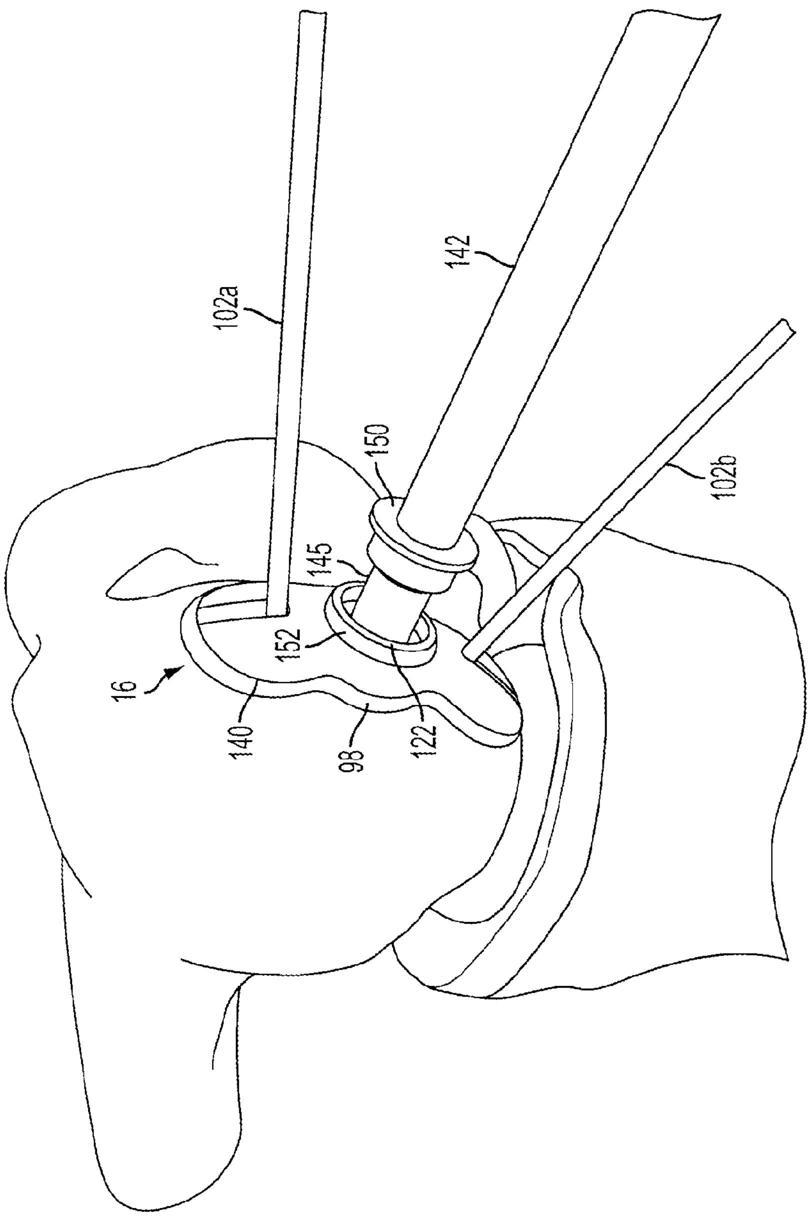

FIG. 28

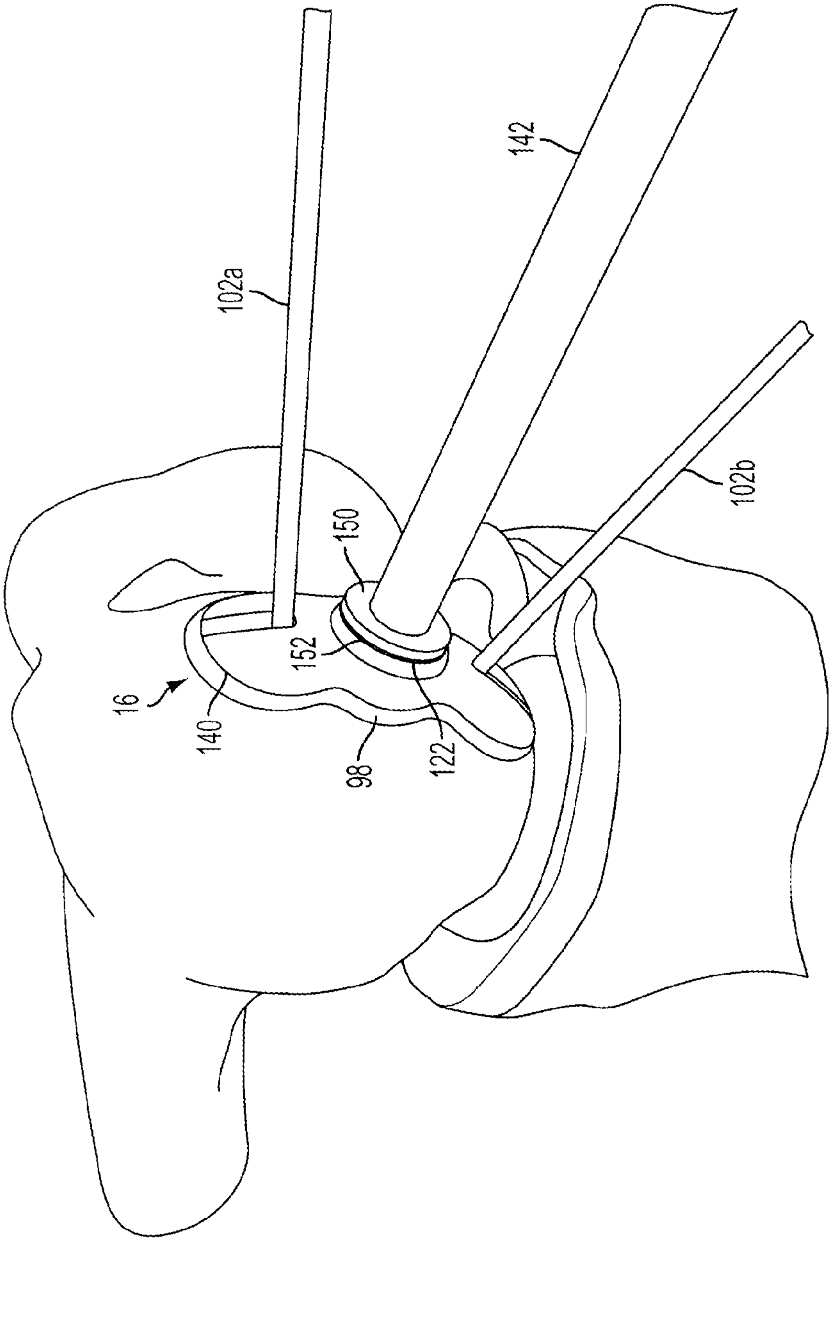

FIG. 29

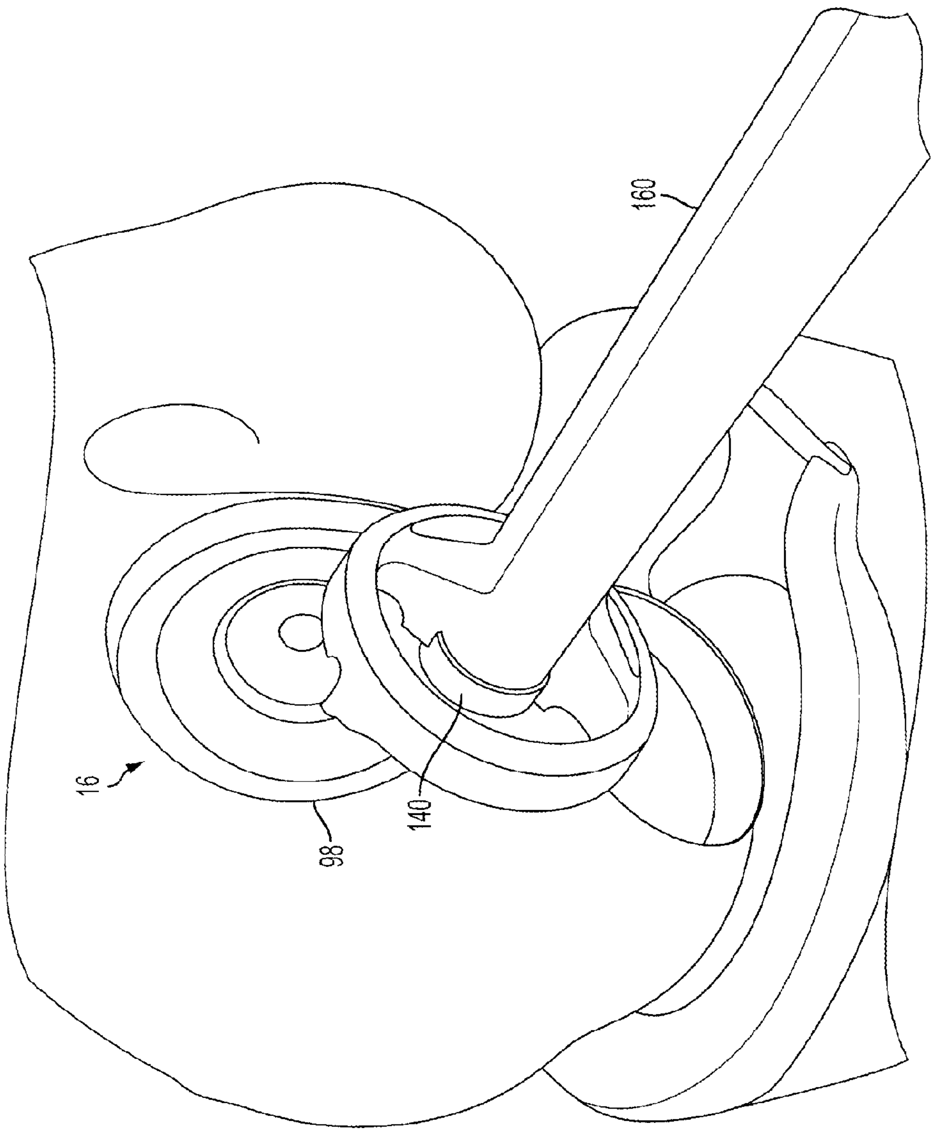

FIG. 30

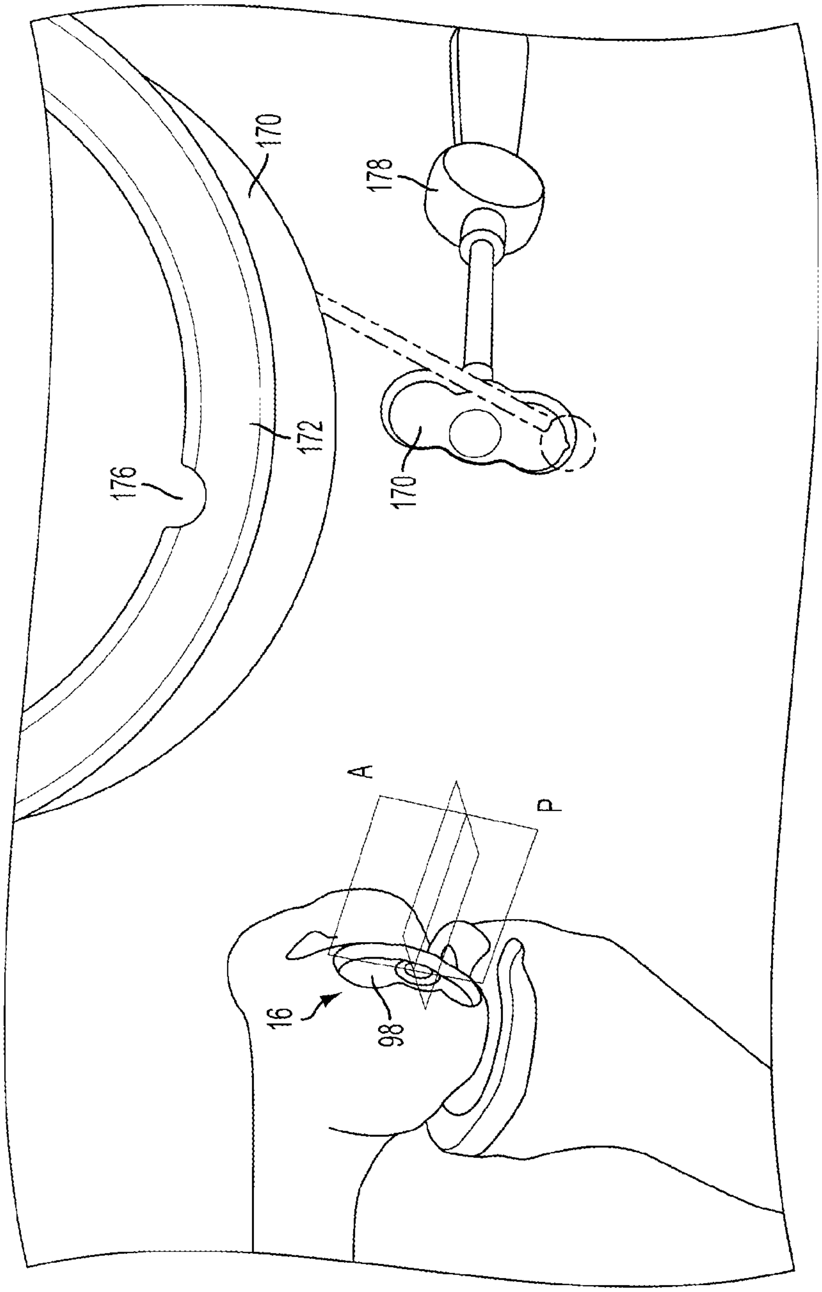

FIG. 31

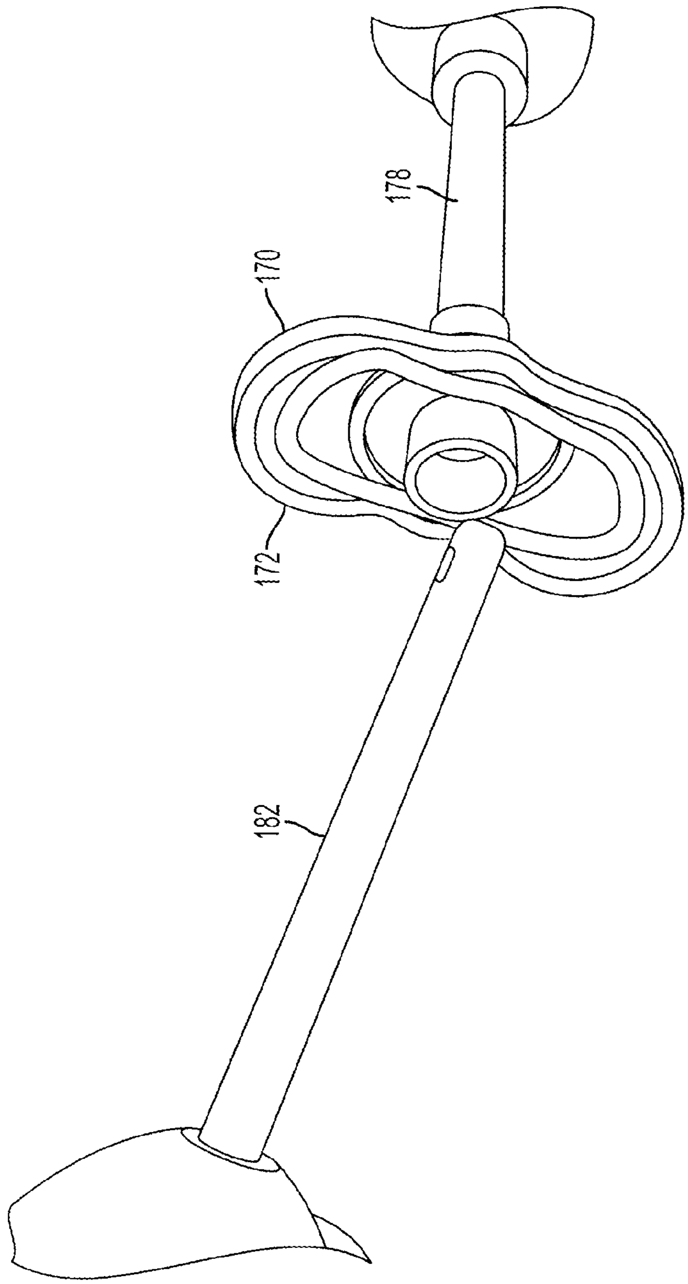

FIG. 32

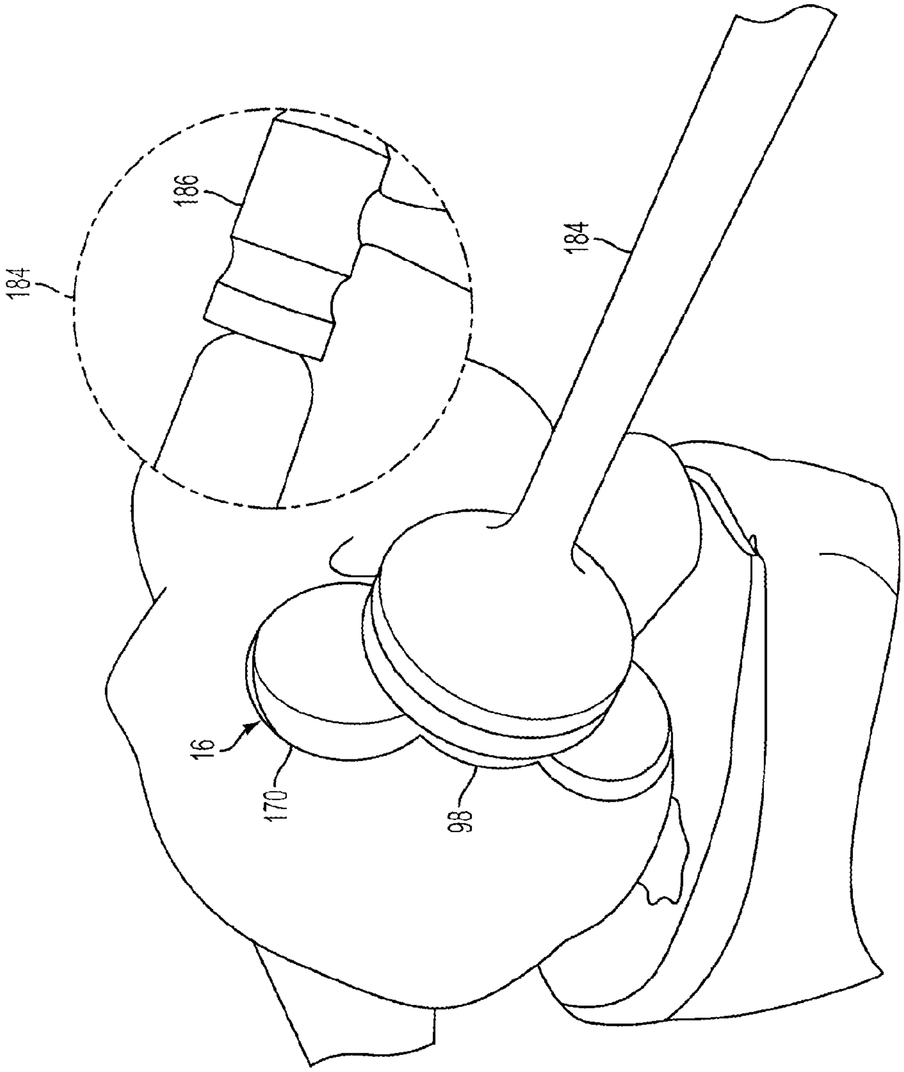

FIG. 33

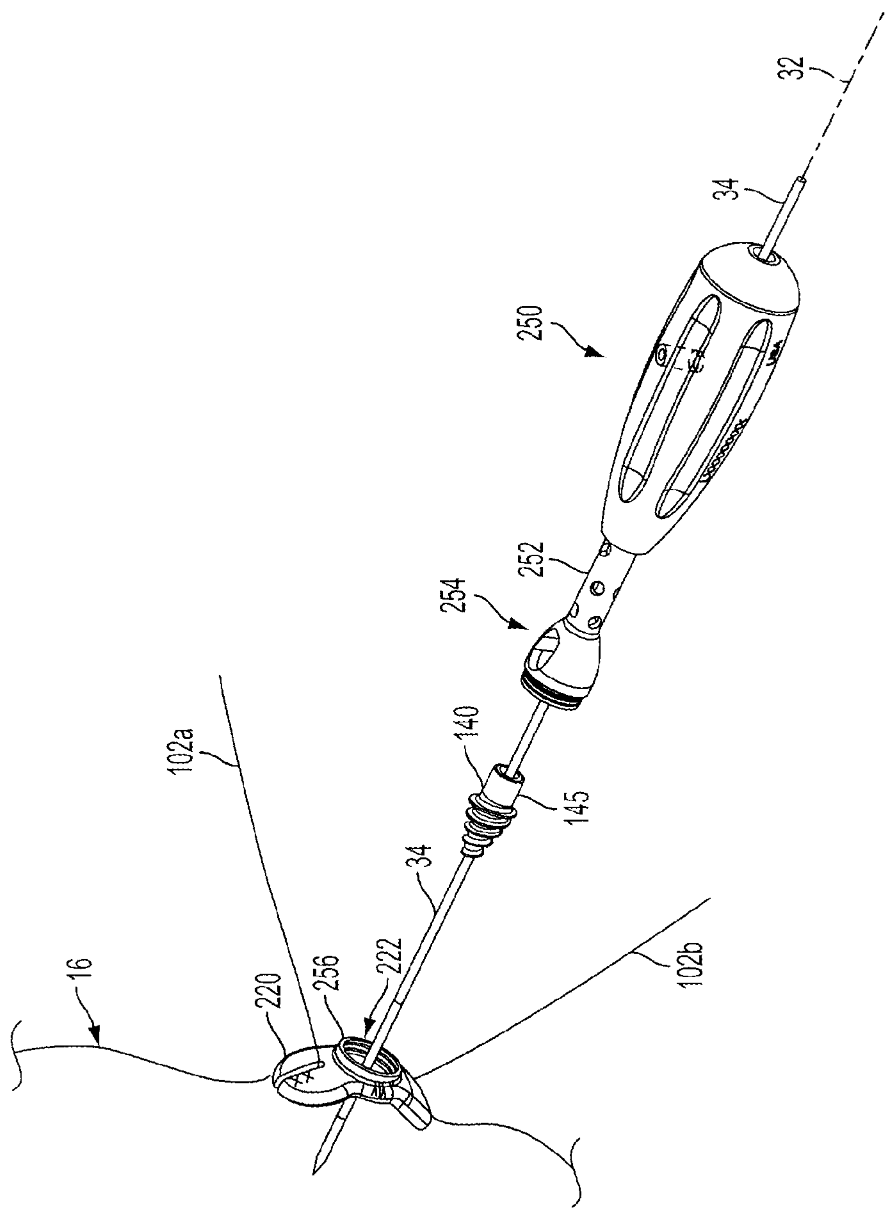

FIG. 34

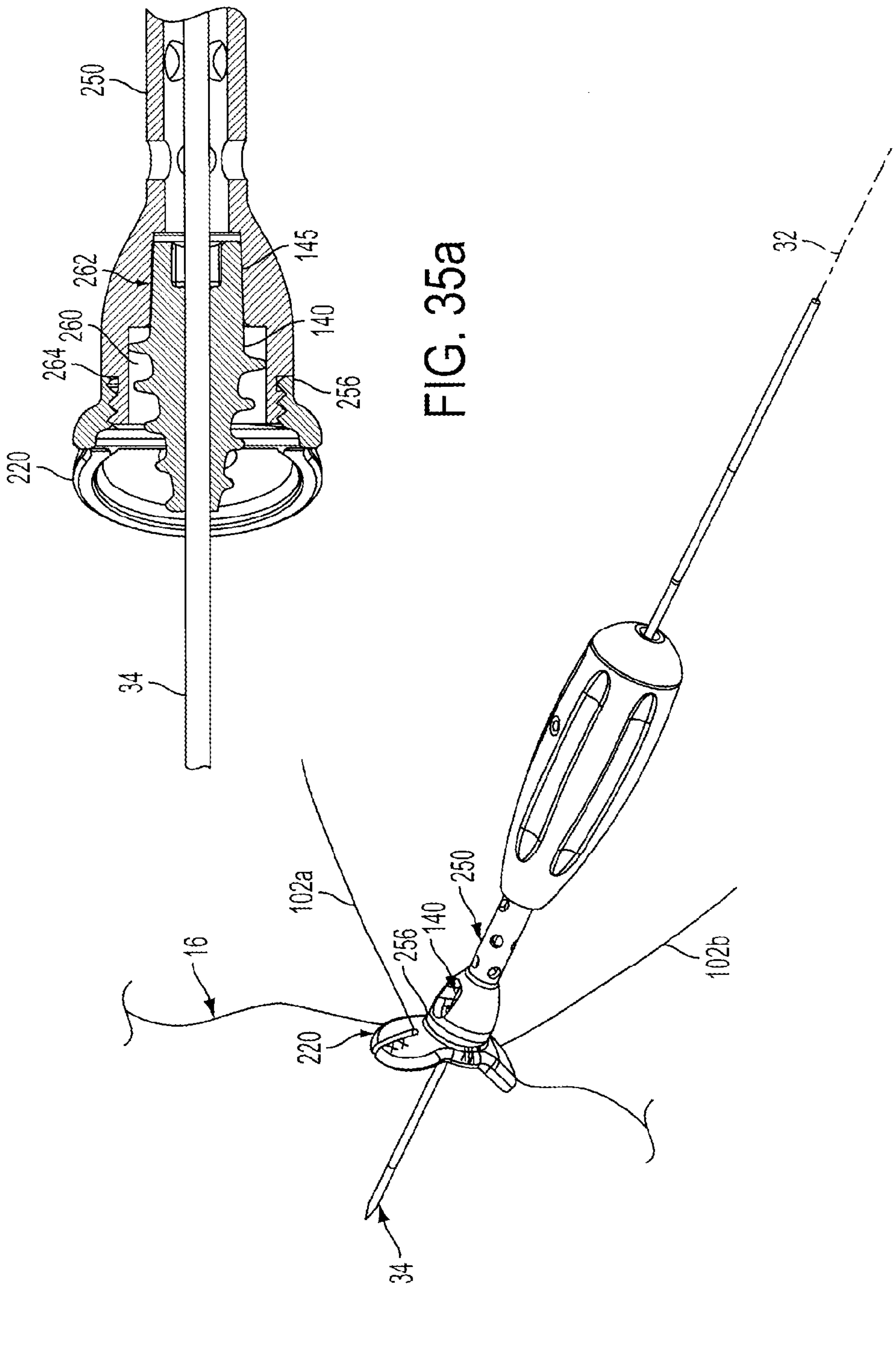

FIG. 35a

FIG. 35

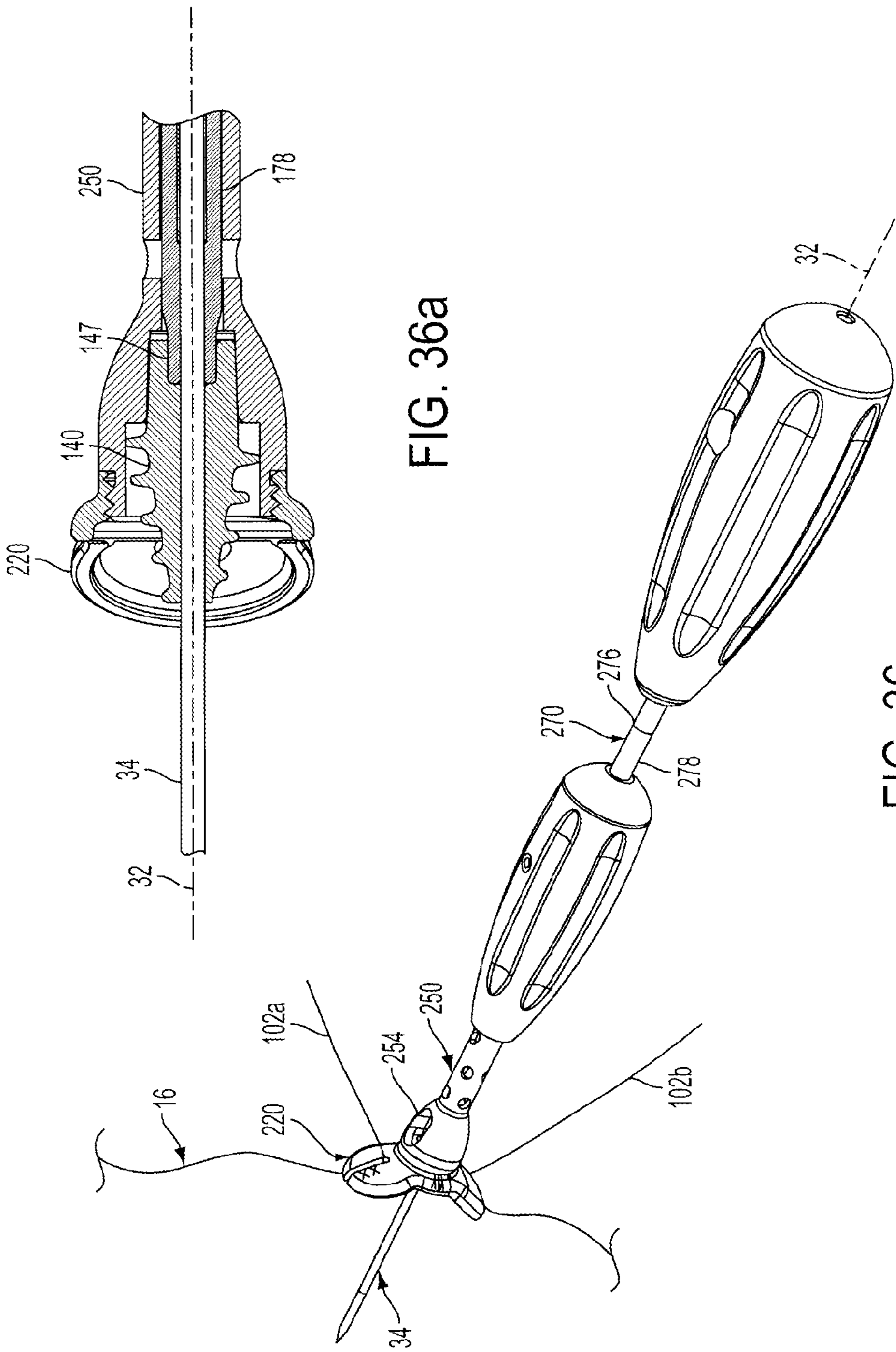

FIG. 36a

FIG. 36

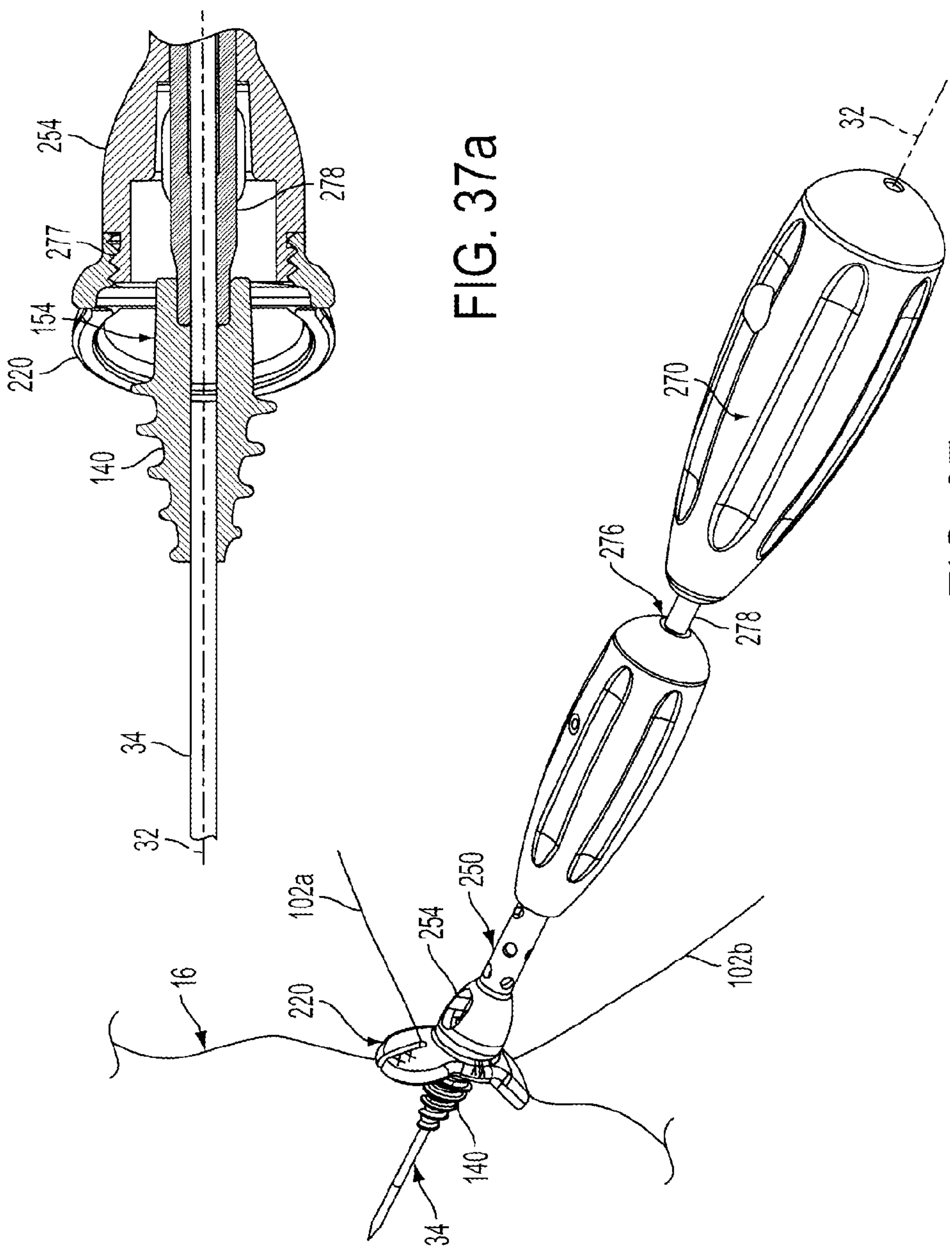

FIG. 37a

FIG. 37

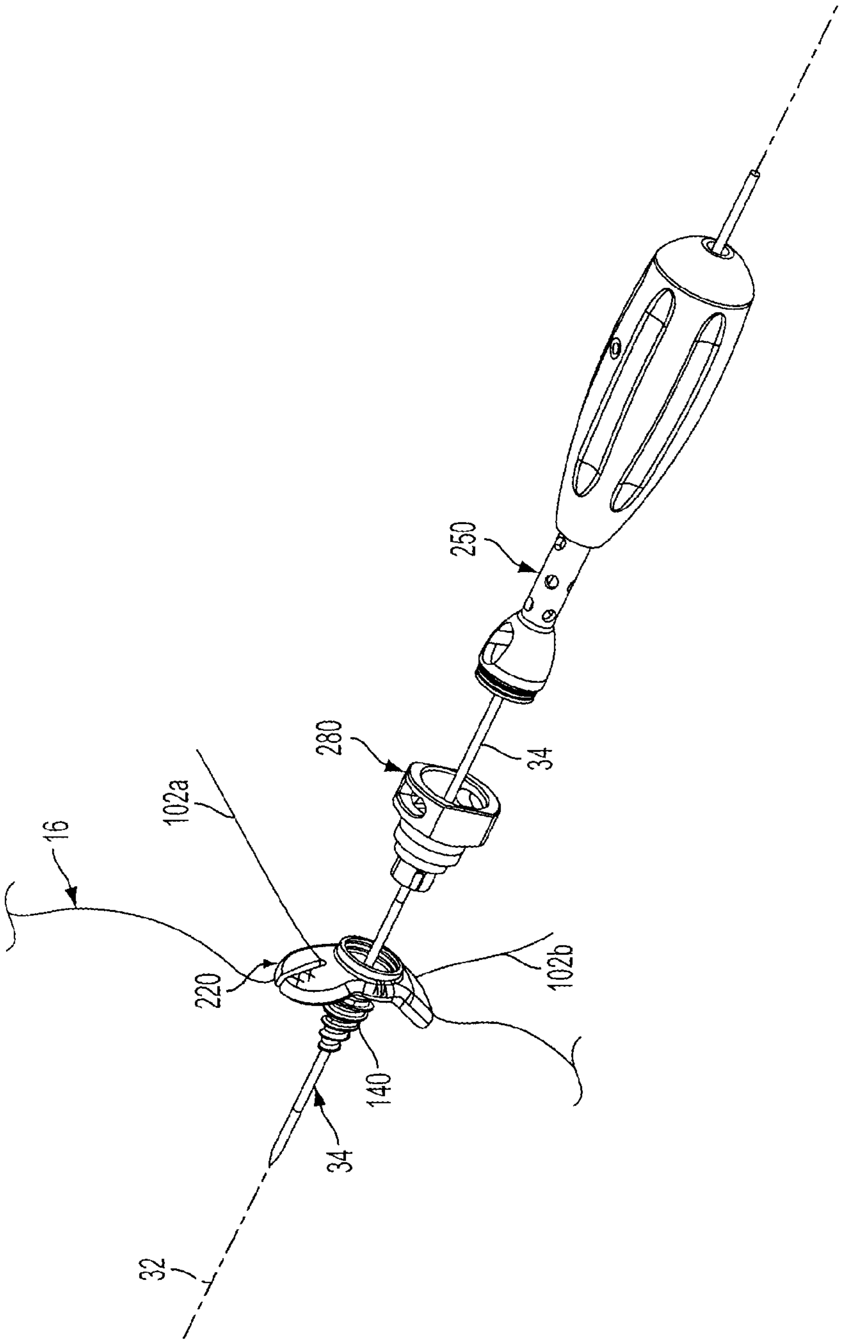

FIG. 38

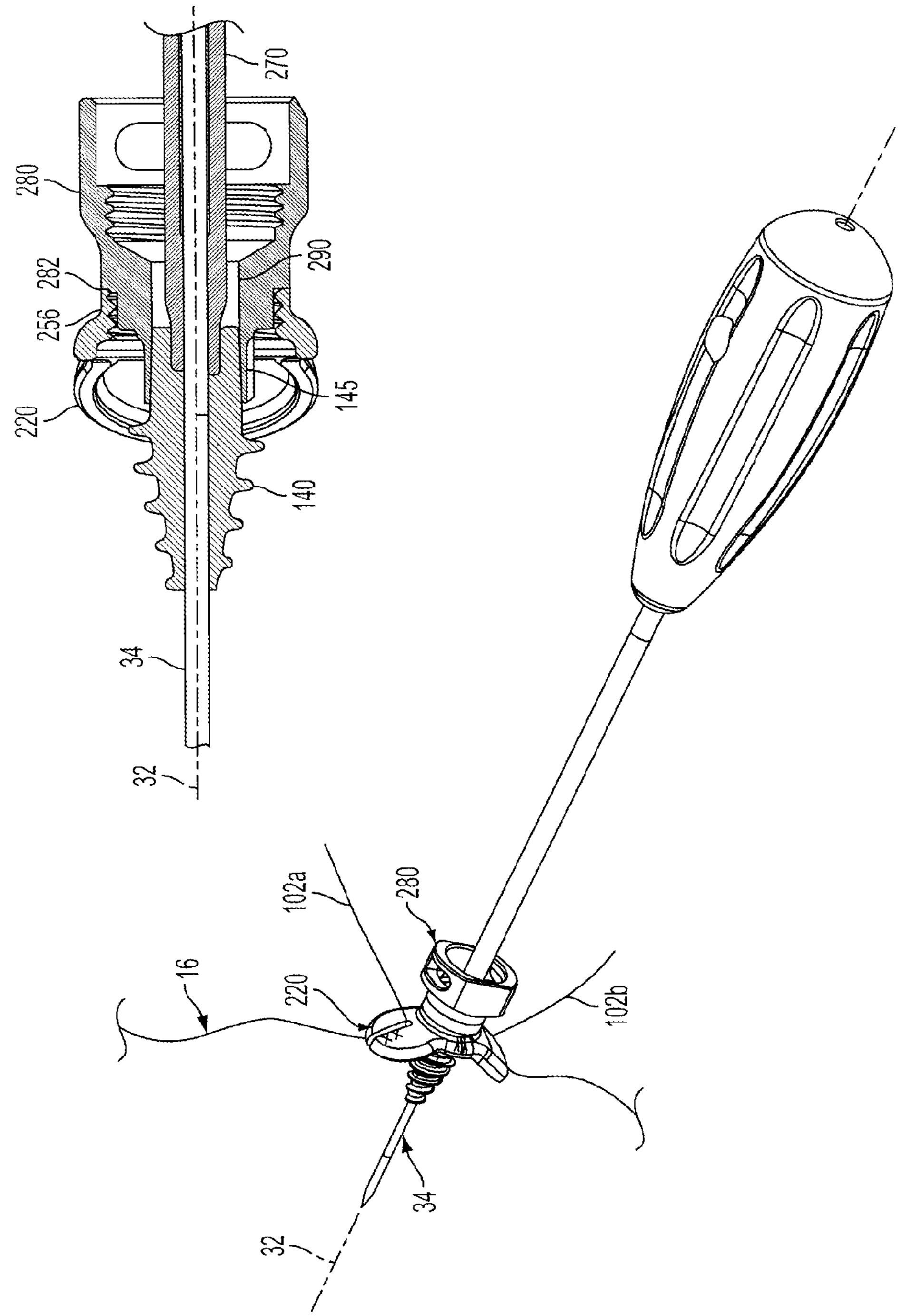

FIG. 39

BONE RESURFACING SYSTEM AND METHOD

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 12/397,095 (now U.S. Pat. No. 7,896,883), filed Mar. 3, 2009, which is a continuation-in-part of U.S. patent application Ser. No. 12/027,121 filed Feb. 6, 2008, which claims the benefit of U.S. Provisional Patent Application Ser. No. 60/888,382, filed Feb. 6, 2007 and which is itself a continuation-in-part of U.S. patent application Ser. No. 11/359,891 (now U.S. Pat. No. 7,713,305), filed Feb. 22, 2006, which itself is a continuation-in-part of U.S. patent application Ser. No. 10/373,463 (now U.S. Pat. No. 7,678,151), filed Feb. 24, 2003, which is a continuation-in-part of U.S. patent application Ser. No. 10/162,533 (now U.S. Pat. No. 6,679,917), filed Jun. 4, 2002, which is itself a continuation-in-part of U.S. patent application Ser. No. 10/024,077 (now U.S. Pat. No. 6,610,067), filed Dec. 17, 2001, which is itself a continuation-in-part of U.S. patent application Ser. No. 09/846,657 (now U.S. Pat. No. 6,520,964), filed May 1, 2001, which claims the benefit of U.S. Provisional Application Ser. No. 60/201,049, filed May 1, 2000. This application is a continuation of Ser. No. 12/397,095 (now U.S. Pat. No. 7,896,883), filed Mar. 3, 2009, which is also a continuation-in-part of U.S. patent application Ser. No. 11/169,326, filed Jun. 28, 2005 which claims the benefit of U.S. Provisional Patent Application Ser. No. 60/583,549, filed Jun. 28, 2004, which is also a continuation-in-part of U.S. patent application Ser. No. 10/994,453 (now U.S. Pat. No. 7,896,885), filed Nov. 22, 2004 which claims the benefit of U.S. Provisional Patent Application Ser. No. 60/523,810, filed Nov. 20, 2003, which is also a continuation-in-part of U.S. patent application Ser. No. 10/308,718, filed Dec. 3, 2002 (now U.S. Pat. No. 7,163,541). This application is a continuation of Ser. No. 12/397,095 (now U.S. Pat. No. 7,896,883), filed Mar. 3, 2009, which also claims the benefit of U.S. Provisional Application Ser. No. 61/033,136, filed Mar. 3, 2008. The entire disclosures all applications and/or patents are incorporated herein by reference.

FIELD

This disclosure relates to devices and methods for the repair of bone surfaces, and particularly to bony articulating joint surfaces.

BACKGROUND

Articular cartilage, found at the ends of articulating bone in the body, is typically composed of hyaline cartilage, which has many unique properties that allow it to function effectively as a smooth and lubricious load-bearing surface. When injured, however, hyaline cartilage cells are not typically replaced by new hyaline cartilage cells. Healing is dependent upon the occurrence of bleeding from the underlying bone and formation of scar or reparative cartilage called fibrocartilage. While similar, fibrocartilage does not possess the same unique aspects of native hyaline cartilage and tends to be far less durable.

In some cases, it may be necessary or desirable to repair the damaged articular cartilage using an implant. While implants may be successfully used, the implant should have a shape substantially corresponding to the articular cartilage proximate the area where the implant is to be placed in order to maximize the patient's comfort, minimize damage to surrounding areas, and maximize the functional life of the implant.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention are set forth by description of embodiments consistent with the present invention, which description should be considered in conjunction with the accompanying drawings wherein:

FIG. **1** is a plain view illustrating an excision;

FIG. **2** is a plain view of a drill guide and a tip;

FIG. **3** is a side view of the drill guide of FIG. **2** disposed about the articular surface;

FIG. **4** is a side view of a pin and the drill guide of FIG. **2**;

FIG. **5** is a plan view of centering shaft and the pin of FIG. **4**;

FIG. **6** is a side view of the centering shaft of FIG. **5** and the pin of FIG. **4** disposed about the articular surface;

FIG. **7** is a plan view of a contract probe, the centering shaft of FIG. **5**, and the pin of FIG. **4**;

FIG. **7***a* is an enlarged view of measuring indicia of the contract probe of FIG. **7**;

FIG. **8** depicts measurements taken along the anterior-posterior (AP) plane and the medial-lateral (ML) plane using the contact probe of FIG. **7**;

FIG. **9** depicts a sizing card;

FIG. **10** is a side view of a surface reamer, the centering shaft of FIG. **5**, and the pin of FIG. **4**;

FIG. **11** is a cross-sectional view of a surface reamer of FIG. **10**, the centering shaft of FIG. **5**, and the pin of FIG. **4**;

FIG. **12** is a perspective view of a guide block and a drill guide;

FIG. **13** is a side plan view of the guide block and drill guide shown in FIG. **12**;

FIG. **14** is a side plan view of the guide block and drill guide shown in FIG. **12** disposed about the articular surface;

FIG. **15** is a side plan view of the guide block and drill guide shown in FIG. **13** including additional pins;

FIG. **16** is a side plan view of the guide block and drill guide shown in FIG. **15** being removed;

FIG. **17** is a side plan view of the pins disposed about the articular surface and a reamer;

FIG. **17***a* is an enlarged view of the shoulder/stop of the reamer of FIG. **17**;

FIG. **18** is a side plan view of an implant sizing trial;

FIGS. **19** and **20** are a side and end plan view of the implant sizing trial of FIG. **18** disposed about the articular surface;

FIG. **21** is a perspective view of a pilot drill and the implant sizing trial of FIG. **18**;

FIG. **22** is a side plan view of the pilot drill of FIG. **21** disposed about the articular surface;

FIG. **23** is a perspective view of a step drill;

FIG. **24** is a perspective view of a tap;

FIG. **25** is a perspective view of a tapered post and a driver;

FIG. **26** depicts the tapered post of FIG. **25** disposed about the articular surface;

FIG. **27** depicts the tapered post of FIG. **25** and the implant sizing trial of FIG. **18** disposed about the articular surface;

FIGS. **28-29** depict the tapered post of FIG. **25** being fully advanced within the articular surface;

FIG. **30** depicts a reamer disposed about the tapered post of FIG. **25**;

FIG. **31** is the bone-facing surface of an implant;

FIG. **32** is the bone-facing surface of an implant of FIG. **31** with an adhesive;

FIG. **33** depicts the implant of FIG. **31** mating with the tapered post of FIG. **25**;

FIG. **34** is a perspective view of a guide handle assembly;

FIG. **35** is a plan view of a guide handle assembly of FIG. **34**;

FIG. **35***a* is an enlarged cross-sectional view of the guide handle assembly of FIG. **35**;

FIG. **36** is a perspective view of the guide handle assembly of FIG. **34** and a driver;

FIG. **36***a* is an enlarged cross-sectional view of the guide handle assembly and the driver of FIG. **36**;

FIG. **37** depicts the tapered post being advanced along the guide pin;

FIG. **37***a* is an enlarged cross-sectional view of FIG. **37**;

FIG. **38** is a perspective view of a trial, placement gauge, and guide handle; and

FIG. **39** is a side plan view of the trial, placement gauge, and guide handle of FIG. **38** disposed about the articular surface.

DETAILED DESCRIPTION

As an overview, the present disclosure is directed to systems and methods for bone resurfacing and for preparing an implant site to resurface bone. While the following detailed description will proceed with reference to resurfacing the femoral condyle of the knee joint, the concepts, methodologies and systems described herein may be applied to any bony surface, for example, articulating joints of the ankle, hip and/or shoulder. In at least one embodiment, the present disclosure may feature a system and method for resurfacing at least a portion of an articular surface having a defect by replacing a portion of the articular surface with an implant. The implant may comprise a load bearing surface having a contour and/or shape substantially corresponding to the patient's original articular surface about the defect site which may be configured to engage an adjacent articular surface. The present disclosure will describe a system and method for replacing a portion of the articular surface of the femoral condyle; however, it should be understood that the system and method according to the present disclosure may also be used to resurface articular surfaces other than the femoral condyle.

As an initial matter, many of the devices described herein comprise cannulated components configured to be arranged over other components. The degree to which the cannulated passageway (i.e., internal diameter of the passageway/cavity) of a first component corresponds to the external diameter of the component over which it is being placed may be close enough to generally eliminate excessive movement. Excessive movement may be defined as an amount of movement that may result in misalignment of the implant relative to the articular surface.

Referring now to FIG. **1**, an incision **10** may be created proximate the patient's knee **12** to provide access to the defect **14** on the patient's articular surface **16**, for example, using a scalpel **18** or the like. Once the incision **10** is created, a drill guide **20**, FIG. **2**, may be advanced against the articular surface **16**. The drill guide **20** may include a cannulated shaft **22**, a proximal end **23** comprising an AP arcuate shaped tip **24** and a first and a second ML prong **26***a*, **26***b*, and optionally a handle **28**. The AP arcuate shaped tip **24** may include two ends **30***a*, **30***b* which may be generally aligned in a first plane and the ML two prongs **26***a*, **26***b* may be arranged in a second plane. These two planes may be configured to be substantially perpendicular to each other as shown. In addition, the AP arcuate shaped tip **24** and the two ML prongs **26***a*, **26***b* may be both coupled to the shaft **22** of the drill guide **20** and moveable with respect to each other by way of a biasing device (not shown) such as a spring or the like.

Turning now to FIG. **3**, because the AP arcuate shaped tip **24** and the two ML prongs **26***a*, **26***b* are moveable with respect to each other, the drill guide **20** may be advanced against the articular surface **16** until the ends **30***a*, **30***b* of the AP arcuate shaped tip **24** contact the articular surface **16** generally along the anterior-posterior (AP) plane of the articular surface **16** and the two ML prongs **26***a*, **26***b* contact the articular surface **16** generally along the medial-lateral (ML) plane of the articular surface **16**. The four points of contact (i.e., ends **30***a*, **30***b* and prongs **26***a*, **26***b*) of the drill guide **20** may be proximate, but generally not within, the defect site **14** and may be used to establish a reference axis **32** (or first working axis **32**) extending from the bone. In one embodiment, the reference axis may extend generally approximately normal to the articular surface **16** about the defect site **14**, however, in other embodiments reference axis may extend from the bone but not necessarily normal to the bone.

Turning now to FIG. **4**, with the four points of the drill guide **20** against the articular surface, a threaded guide pin **34** may be advanced through the cannulated drill guide **20** along the reference axis **32** and into the bone beneath the defect site **14**, for example using a drill or the like. To that end, arcuate shaped tip **24** of the drill guide **20** may also include a bore or passageway aligned with the lumen in the cannulated handle. The guide pin **34** may include one or more indicia **36** (for example, but not limited to, laser markings or the like) on the shaft **38** of the guide pin **34** that may be used to control the depth of the guide pin **34** into the bone. By way of example, the indicia **36** on the guide pin **34** may be set relative to the length of the drill guide **20** such that the depth of the guide pin **34** is set when the indicia **36** is aligned with the distal end **40** of the drill guide **20** (i.e., the end opposite the AP arcuate shaped tip **24** and the ML prongs **26***a*, **26***b*). Once the guide pin **34** is coupled to the bone, the drill and the drill guide **20** may be removed leaving just the guide pin **34** coupled to the bone and extending along the reference axis **32** (i.e., substantially normal to the original articular surface about the defect site **14**). It should be noted that the cannulated passageway of the drill guide **20** may have an internal diameter substantially corresponding to the outer diameter of the guide pin **34**.

Turning now to FIG. **5**, a centering shaft **40** may be advanced over the guide pin **34**. The centering shaft **40** may be cannulated and may comprise a tap **42** at a first end of the cannulated shaft **44**. At least a portion of the tap **42** (for example, a portion proximate the first end of the cannulated shaft **44**) may extend radially outwardly beyond the outer surface of the cannulated shaft **44** to form a shoulder or abutting surface **45**. The centering shaft **40** may be advanced into the bone until a marking **46** (such as, but not limited to, a laser marking or the like) is substantially flush with the original articular surface **16** over the defect site **14** as generally shown in FIG. **6**. As may be appreciated, the alignment of the marking **46** with the original articular surface **16** of the defect site **14** may have to be estimated. In addition, it should be noted that the marking **46** may not be aligned to be flush with the actual defect site **14**.

Next, measurements of the patient's articular surface may be taken in order to determine the appropriate contour of the implant. Referring to FIG. **7**, one or more contact probes **50** may be advanced over the centering shaft **40** and/or the guide pin **34**. The contact probe **50** may comprise a cannulated shaft **52** and an outrigger **54** extending radially outwardly and axially outwardly from a distal end **55** of the cannulated shaft **52**. A first and a second contact probe **50***a*, **50***b* may be provide having outriggers **54** extending radially outwardly at a distance of 40 mm and 20 mm, respectively. Of course, other distances are also possible depending on the size of the implant to be delivered as well as the geometry of the defect site **14** and/or the articular surface **16**.

The contact probe **50** may also include measuring indicia **56**, which may optionally be disposed in a portion of a handle **58**. A close up of one embodiment of the measuring indicia **56** is shown in FIG. **7***a*. The measuring indicia **56** may include a plurality of measurement markings **60** indicating relative distances. In use, the contact probe **50** may be placed over the centering shaft **40** such that the distal end **62** of the outrigger **54** contacts the articular surface **16**. A measurement may be taken by based on the alignment of at least one marking on the centering shaft **40** (for example, the second end **64** of the centering shaft) with the plurality of measurement markings **60**.

Turning now to FIG. **8**, a first (and optionally a second) measurement of the patient's articular surface **16** proximate the defect site **14** may be taken along the AP plane using the first contact probe **50***a* by placing the distal end **62** of the 40 mm outrigger **54** against the patient's articular surface **16**. In addition, a first (and optionally a second) measurement of the patient's articular surface **16** proximate the defect site **14** may be taken along the ML plane using the second contact probe **50***b* by placing the distal end **62** of the 20 mm outrigger **54** against the patient's articular surface **16**. The size of the outriggers **54** may be selected based on the size of the defect site **14** such that the distal end **62** of the outrigger **54** contacts the articular surface **16** and not the defect site **14**.

The measurements obtained from the contact probes **50***a*, **50***b* may be recorded onto a sizing card **70**, FIG. **9**. The sizing card **70** may include a first area **72** graphically representing the AP and the ML planes. In particular, a first and a second query box **74***a*, **74***b* may be provided to fill in the first and second AP measurements and a first and a second query box **76***a*, **76***b* may be provided to fill in the first and second ML measurements. The query boxes **74***a*, **74***b* may optionally be connected by a circle representing the size of the outrigger **46** of the first contact probe **50***a* while query boxes **76***a*, **76***b* may optionally be connected by a circle representing the size of the outrigger **46** of the second contact probe **50***b*. The sizing card **70** may also include query boxes **78***a*, **78***b* provided to fill in the maximum values of the AP plane and the ML plane, respectively.

Based on the maximum values of the AP and ML plane in query boxes **78***a*, **78***b*, the offset values of the implant and test implant may be determined. As shown, the surgeon may select from a set of implants having predetermined offset values **79***a-c*. The values **79***a-c* correspond to the AP measurement **79***a*, ML measurement **79***b*, and depth **79***c* of the implant/test implant. It should be noted that the offset values of the implant/test implant may be used in combination with known geometrical ratios of the articular surface for a particular region of the articular surface. These geometric ratios may be found in published literature and may be utilized, for example, when the implant is placed proximate the interface between the posterior and distal regions of the articular surface. If further accuracy is desired (for example, but not limited to, defects extending further towards the posterior region and/or the anterior regions of the articular surfaces), the contour of the implant and articular surface may be determined as described in U.S. patent application Ser. No. 12/027,121 entitled System and Method for Joint Resurface Repair filed Feb. 6, 2008, which is fully incorporated herein by reference.

Turning now to FIG. **10**, the diameter of a surface reamer **80** may be selected based on, for example, the maximum ML value (e.g., the value filled in query box **78***b* of sizing card **70**). The surface reamer **80** may include a cannulated shaft **82** configured to be disposed over the centering shaft **40** and/or the guide pin **34** along the reference axis **32** and coupled to a drill **81**. The surface reamer **80** may also include one or more cutting surfaces **84** and a shoulder **86** disposed about the opening **88** of the cannulated shaft **82**.

The surface reamer **80** may be advanced over the centering shaft **40** and/or the guide pin **34** along the reference axis **32** until the shoulder **86** of the surface reamer **80** abuts against the shoulder **45** of the centering shaft **40** as shown in FIG. **11**. The contact between the two shoulders **86**, **45** may be configured to control the depth of the excision in the articular surface. The cutters **84** may optionally be positioned about the surface reamer **80** to leave more material proximate the centering shaft **40** and/or the guide pin **34** along the reference axis **32** to facilitate removal and insertion of devices further along the method. Once the articular surface **16** has been excised about the reference axis **32**, the surface reamer **80** and the centering shaft **40** may be removed.

A guide block **90**, FIG. **12**, may be selected based on the maximum AP measurement value taken previously (e.g., the value filled in query box **78***a* of sizing card **70**). The guide block **90** may be used to establish one or more working axis (for example, a superior and inferior working axis) for excising the articular surface **16** on either side of the reference axis along the AP plane. The guide block **90** may include a body **92** having an arcuate shaped interior surface **94** configured to contact the articular surface **16** along at least two points (e.g., the two end regions of the guide block **90**). The guide block **90** may comprise a first bushing **95** defining a passageway or bore sized to receive the guide pin **34**. The guide block **90** may be configured to be coupled to the drill guide **20**. For example, according to one embodiment the AP arcuate shaped tip **24** may be removed from the drill guide **20** as shown in FIG. **12** and the guide block **90** may be coupled to the drill guide **20** with the first bushing **95** aligned with the cannulated passageway of the drill guide **20** as generally shown in FIG. **13**.

Turning now to FIG. **14**, the first bushing **95** of the guide block **90** may be advanced along the guide pin **34** towards the articular surface **16**, for example using the drill guide **20**, such that the guide block **90** is generally aligned along the AP plane of the articular surface **16** and the ML prongs **26***a*, **26***b* of the drill guide **20** contact the bone within the excision site **98** formed by the surface reamer **80**. The guide block **90** may include a superior and inferior pin sleeve receiver **99***a*, **99***b* configured to removably receive a superior and inferior pin sleeve **100***a*, **100***b*, respectively. The superior and inferior pin sleeve **100***a*, **100***b* may be provided to facilitate proper alignment of the inferior and superior working axis.

For example, a first and a second threaded pin **102***a*, **102***b*, FIG. **15**, may be advanced through the superior and inferior pin sleeve **100***a*, **100***b* (for example, using a drill or the like) along the superior and inferior axis **101***a*, **101***b*. The depth of the pins **102***a*, **102***b* may be controlled using markings (for example, but not limited to, laser markings) disposed on the shaft **104** of the pins **102***a*, **102***b*.

Once the superior and inferior pins **102***a*, **102***b* are coupled to the bone, the superior and inferior pin sleeves **100***a*, **100***b* may be removed from the superior and inferior pin sleeve receivers **99***a*, **99***b*. Turning now to FIG. **16**, the guide block **90** may now be removed from the articular surface along the guide pin **34**. The superior and inferior pin sleeve receivers **99***a*, **99***b* may be provided with slots **104***a*, **104***b* configured to allow the superior and inferior pins **102***a*, **102***b* to pass through the guide block **90** as the guide block **90** is slid along the guide pin **34**.

Once the guide block is removed and the superior and inferior pins **102***a*, **102***b* have been established, the guide pin **34** may be removed. Next, a first and a second cannulated reamer **110**, FIG. **17**, may be advanced over the superior and inferior pins **102***a*, **102***b* to excise a first and a second portion of the articular surface **16** about the superior and inferior pins **102***a*, **102***b*. The reamer **110** may have one or more cutting surfaces **112** and may be provided with a depth stop **114** configured to control the depth of the excision sites about the superior and inferior pins **102***a*, **102***b*. According to one embodiment, the depth stop **114**, FIG. **17***a*, may comprise a shoulder or stop **116** disposed within the cannulated passageway **118** of the reamer **110**. The shoulder or stop **116** may be configured to engage with a distal end of the superior and inferior pins **102***a*, **102***b*, thereby preventing the reamer **110** from being advanced any further along the superior and inferior pins **102***a*, **102***b* and controlling the depth of the excision sites.

Turning now to FIG. **18**, an implant sizing trial **120** may be selected based on the measurements taken of the articular surface **16**. The implant sizing trial **120** may comprise a shape/contour generally corresponding to the shape/contour of the implant to be delivered. The implant sizing trial **120** may comprise a threaded opening **122** configured to be concentrically disposed about the working axis **32**. The threaded opening **122** may also be configured to be threadably engaged with a cannulated shaft/handle **126**. The implant sizing trial **120** may also include superior and inferior slots **128***a*, **128***b* configured to allow the implant sizing trial **120** to be advanced over the superior and inferior pins **102***a*, **102***b* as it is inserted into the excision sites **98** in the articular surface **16**. Once the implant sizing trial **120** is inserted into the excision sites **98** in the articular surface **16**, the fitment of the implant sizing trial **120** along the AP and ML planes may be confirmed visually as generally shown in FIGS. **19** and **20**.

With the implant sizing trial **120** inserted within the excision sites **98** and the fitment confirmed, a cannulated pilot drill **130**, FIG. **21**, may be advanced through the handle **126** and the implant sizing trial **120** into the bone along the reference axis **32**. The pilot drill **130** may also include a depth control device such as, but not limited to, a marking (e.g., a laser marking or the like). With the cannulated pilot drill **130** secured in the bone, the implant sizing trial **120** and handle **126** may be removed and the guide pin **34** may be advanced through the cannulated passageway of the pilot drill **130** into the bone along the reference axis **32** as shown in FIG. **22**. Again, the depth of the guide pin **34** may be controlled by way of a marking **132** (e.g., a laser marking or the like) along the shaft of the guide pin **34**. For example, the depth of the guide pin **34** may be set once the laser marking **132** is flush with the end of the pilot drill **130**.

Turning now to FIG. **23**, a cannulated step drill **134** may be advanced over the pilot drill **130** and the guide pin **34** into the articular surface **16** about the reference axis **32**. The use of the pilot drill **130** and the cannulated step drill **134** may be configured to incrementally provide a larger opening in the bone about the reference axis **32** in the articular surface **16** to reduce the potential of chipping the bone about the reference axis **32**. The cannulated step drill **134** may also include a depth stop for controlling the depth of the step drill **134** into the bone, for example, as generally described above with respect to FIG. **17***a*.

Once the depth of the step drill **134** is set, the step drill **134** and the pilot drill **130** may be removed and a cannulated tap **136** may be advanced over the guide pin **34** as generally shown in FIG. **24**. The depth that the tap **136** is advanced into the bone may be controlled based on a marking (e.g., a laser marking) on the guide pin **32**. The tap **136** may be configured to provide a threaded opening **138** in the bone about the reference axis **32** to threadably receive the implant post as will be described below.

With the opening about the reference axis **32** tapped, the tap **136** may be removed and the tapered post **140**, FIG. **25**, may be advanced over the guide pin **34** at least partially into the threaded opening **138**, for example, using a hex driver **142**. The tapered post **140** may include a tapered and threaded first end **144** and a second end **145** having a tapered exterior surface **146**, for example, as described in U.S. Pat. Nos. 6,520,964, 6,610,067 and 6,679,917, all of which are fully incorporated herein by reference. The second end **145** may also include a hex-shaped internal cavity **147** configured to engage with a corresponding hex-shaped driver **148** of the hex driver **142**. Both the tapered post **140** and the hex driver **142** may be cannulated such that they may be advanced over the guide pin **34**.

Referring now to FIG. **26**, the tapered post **140** may be advanced along the guide pin **34** and partially inserted into the threaded opening **138** (for example, approximately half way) using the hex driver **142**. According to one embodiment, the tapered post **140** may be inserted in the threaded opening **138** such at least most of the threaded end **144** is within the threaded opening **138**. Once the tapered post **140** is partially received in the threaded opening **138**, the hex driver **142** may be removed

Turning now to FIG. **27**, the implant sizing trial **120** may be placed into the excision sites **98**. As can be seen, the second end **145** of the tapered post **140** may at least partially extend through the threaded opening **122** of the implant sizing trial **120**. Using the hex driver **142**, the implant sizing trial **120** may be fully advanced into the threaded opening **138** as generally shown in FIG. **28**. The hex driver **142** may include a flared end **150** which may engage a shoulder **152** disposed about the opening **122** in the implant sizing trial **120** as shown in FIG. **29**. The engagement of the flared end **150** and the shoulder **152** may control the final depth of the tapered post **140** into the threaded opening **138** in the bone.

Once the tapered post **140** is fully advanced into the threaded opening **138**, the hex driver **142**, implant sizing trial **120** and superior and inferior pins **102***a*, **102***b* may be removed. Optionally, a cannulated reamer **160**, FIG. **30**, may be advanced over the guide pin **34** to remove any excess material about the reference axis **32**. The depth of the reaming may be controlled when the shoulder **162** of the reamer **160** contacts the end of the tapered post **140** in a manner similar to that of FIG. **11** described above. The reaming may be provided to extra material left about the reference axis **32** during the reaming discussed with respect to FIGS. **10** and **11**. This extra material may have been left to prevent accidental chipping during the subsequent operations.

After the final reaming, the reamer **160** and the guide pin **32** may be removed leaving behind only the tapered post **140** in the bone. Next, the implant **170**, FIG. **31**, may be selected base on the measurements taken of the patient's articular surface **16**. As discussed previously, the implant **170** may have a load bearing surface including a contour based on the measurements taken of the patient's articular surface **16** such that the load bearing surface generally corresponds to the patient's original articular surface **16**. According to one embodiment, the implant **170** may include an implant as described in U.S. patent application Ser. No. 10/373,463 filed Feb. 24, 2003, U.S. Pat. No. 6,679,917 issued Jan. 20, 2004, U.S. Pat. No. 6,610,067 issued Aug. 26, 2003, U.S. Pat. No. 6,520,964 issued Feb. 18, 2003, and U.S. Provisional Application Ser. No. 60/201,049 filed May 1, 2000, all of which are fully incorporated hereby incorporated by reference.

The bone facing surface **172** of the implant **170** may include indicia **176** representing either posterior and/or anterior sides of the implant **170**. This indicia **176** may be used by the surgeon to properly align the implant **170** along the AP and ML planes within the excision site **98**. The implant **170** may be inserted into the excision site **98** using a grasping device **178** such as, but not limited to, a suction cup coupled to a handle.

Turning now to FIG. **32**, an adhesive **180** (such as, but not limited to, bone cement or the like) may be applied to the bone facing surface **172** by way of a dispenser **182**, for example a dispenser as described in U.S. patent application Ser. No. 12/031,534 entitled Bone Cement Delivery Device filed on Feb. 14, 2008 which is fully incorporated herein by reference. The implant **170** may include a female opening configured to frictionally engage with the tapered second end of the tapered post **140**. For example, the implant **170** may be mated in the excision site **98** and to the tapered post **140** using an impactor **184** and hammer **186** as shown in FIG. **33**.

According to another embodiment, the tapered post **140** may be advanced into the bone as follows. After forming a threaded opening **138** (for example, but not limited to, as described above with respect to FIG. **24**), an implant sizing trial **220** may be advanced along the guide pin **34** into the excision site **98** as generally shown in FIG. **34**. The implant sizing trial **220** may be similar to the implant sizing trial **120** described above, however, the implant sizing trial **220** according to this embodiment may include a threaded opening **222** having a diameter large enough to allow the tapered post **140** to be advanced along the guide pin **34** (and therefore the reference axis **32**) through the threaded opening **222** and into the bone. The implant sizing trial **220** may be advanced along the guide pin **34** using a guide handle assembly **250**. The guide handle assembly **250** may include a cannulated shaft **252** to receive the guide pin **34** and may also include a flared end **254** configured to receive the tapered second end **145** of the tapered post **140**.

For example, turning to FIG. **35**, the guide handle assembly **250** and the tapered post **140** are shown together with the implant sizing trial **220**. As can be seen, the flared end **254** of the guide handle assembly **250** may be configured to engage with a shoulder **156** of the implant sizing trial **220** proximate the threaded opening **222**. Referring now to FIG. **35***a*, a close up of the flared end **254** of the guide handle assembly **250** and the tapered post **140** is shown. The flared end **254** may define an internal cavity **260** configured to at least partially receive the tapered post **140**. In particular, the internal cavity **260** may include a tapered portion **262** configured to frictional engage with the tapered second end **145** of the tapered post **140**. Additionally, as can be seen, the flared end **254** of the guide handle assembly **250** may include a shoulder **264** configured to engage against the shoulder **256** of the implant sizing trial **220**. At this point, the tapered post **140** may or may not be partially received within the threaded opening **138**. The final depth of the tapered post **140** may also not be set.

Turning now to FIG. **36**, the tapered post **140** may be partially advanced into the threaded opening **138** using a hex driver **270**. For example, the hex driver **270** may be advanced along the guide pin **34** and the reference axis **32** through the cannulated passageway of the guide handle assembly **250**. The hex driver **270**, FIG. **36***a*, may include a male hex adapter **272** configured to engage with a corresponding female hex adapter **147** of the tapered post **140**.

With the shoulder **264** of the guide handle assembly **250** abutting against the shoulder **256** of the implant sizing trial **220**, the tapered post **140** may be advanced along the guide pin **34** and the reference axis **32** as shown in FIG. **37** using the hex driver **270**. According to one embodiment, the tapered post **140** is advanced most of the way into the bone and the depth may be set based on a marking **276** (for example a laser marking or the like) on the shaft **278** of the hex driver **270**. This marking **276** may be used to set the tapered post **140** close to the final depth in the bone, for example by aligning the marking **276** with the distal end of the guide handle assembly **250**. Alternatively, it may be possible to set the final depth of the tapered post **140** based on this marking **276** and the guide handle assembly **250**. As may be seen in FIG. **37***a*, flared end **254** of the guide handle assembly **250** may include a threaded region **277** that may engage with the threaded opening **222** of the implant sizing trial **220**. Additionally, the tapered second end **154** of the tapered post **140** may be at least partially removed from the tapered portion **262** of the flared end **254** of the guide handle assembly **250** once the marking **276** is aligned with the guide handle assembly **250**.

Turning now FIG. **38**, the hex driver **270** and the guide handle assembly **250** may be removed and a placement gauge **280** may be advanced along the guide pin **34** towards the implant sizing trial **220**. The placement gauge **280** may be used to set the final depth of the tapered post within the bone. The placement gauge **280** may be advanced along the guide pin **34** using the guide handle assembly **250**. As shown in FIG. **39**, the placement gauge **280** may include a tapered female cavity **290** configured to engage with the tapered second end **145** of the tapered post **140** in a manner substantially the same as the implant will ultimately engage with the tapered post **140**.

With the tapered female cavity **290** of the placement gauge **280** frictionally engaged with the tapered post **140**, the placement gauge **280** and the tapered post **140** may be advanced along the guide pin **34** using the hex driver **270** until a shoulder **282** of the placement gauge **280** abuts against the shoulder **256** of the implant sizing trial **220**. The final depth of the implant **140** may be set based on the implant sizing trial **140** (and in particular, the depth of the shoulder/boss **256**) and the depth of the tapered post **140** within the tapered cavity **290** of the placement gauge **280**.

Once the tapered post **140** is set in the bone, the hex driver **270**, placement gauge **280**, and the implant sizing trial **220** maybe removed. Once removed, the guide pin **34** may be removed and (if still in place), the pins **102***a*, **102***b* may also be removed. The implant may then be coupled to the tapered post **140** as generally described above.

The following patents or patent applications filed by the applicant or assignee of the present invention are hereby incorporated by reference in their entireties:

U.S. Pat. No. 6,520,964 entitled System and method for joint resurface repair;

U.S. Pat. No. 6,610,067 entitled System and method for joint resurface repair;

U.S. Pat. No. 7,029,479 entitled System and method for joint resurface repair;

U.S. Pat. No. 6,679,917 entitled System and method for joint resurface repair;

U.S. Pat. No. 7,163,541 entitled Tibial resurfacing system;

U.S. Pat. No. 7,678,151 entitled System and method for joint resurface repair;

U.S. Pat. No. 7,713,305 entitled Articular surface implant;

U.S. Pat. No. 7,510,558 entitled System and method for joint resurface repair;

U.S. Pat. No. 7,604,641 entitled System and method for joint resurface repair;

U.S. Pat. No. 7,618,463 entitled System and method for joint resurface repair;

U.S. patent application Ser. No. 12/027,121 entitled System and method for joint resurface repair;

U.S. patent application Ser. No. 10/789,545 entitled Articular Surface Implant;

U.S. patent application Ser. No. 11/461,240 entitled System and method for articular surface repair;

U.S. patent application Ser. No. 11/169,326 entitled System for articular surface replacement;

U.S. patent application Ser. No. 11/209,170 entitled System and method for retrograde procedure;

U.S. Pat. No. 7,828,853 entitled Articular surface implant and delivery system;

U.S. patent application Ser. No. 11/326,133 entitled System and method for retrograde procedure;

U.S. patent application Ser. No. 11/551,912 entitled Retrograde excision system and apparatus;

U.S. patent application Ser. No. 12/001,473 entitled Retrograde resection apparatus and method;

U.S. patent application Ser. No. 11/779,044 entitled System and method for tissues resection; and

U.S. patent application Ser. No. 12/031,534 entitled Bone cement delivery device.

As mentioned above, the present disclosure is not intended to be limited to a system or method which must satisfy one or more of any stated or implied object or feature of the present disclosure and should not be limited to the preferred, exemplary, or primary embodiment(s) described herein. The foregoing description of a preferred embodiment of the present disclosure has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the present disclosure to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment was chosen and described to provide the best illustration of the principles of the present disclosure and its practical application to thereby enable one of ordinary skill in the art to utilize the present disclosure in various embodiments and with various modifications as is suited to the particular use contemplated. All such modifications and variations are within the scope of the present disclosure.

What is claimed is:

1. A method for preparing an implant site, comprising:

establishing a first working axis extending from an articular surface;

establishing a second working axis extending from said articular surface, said second working axis is displaced from said first working axis;

creating a first socket through said articular surface and partially into said bone by reaming about said first working axis; and

creating a second socket through said articular surface and partially into said bone by reaming about said second working axis;

wherein said first and said second sockets partially overlap with and extend beyond each other.

2. The method of claim **1**, wherein said first and second said working axes are established, in part, by advancing first and second guide pins into said articular surface, said guide pins extending from said articular surface.

3. The method of claim **1**, wherein said first and said second working axes are established by placing a guide block onto the surface of the articular surface such that at least two opposing points of the guide blocks contact said articular surface, said guide block having first and second bores therein defining the location of said first and second working axes with respect to said articular surface.

4. The method of claim **1**, further comprising:

establishing a third working axis extending from said articular surface, wherein said third working axis is displaced from said first and second working axes; and

creating a third socket through said articular surface and partially into said bone, adjacent said first and second sockets, by reaming about said third working axis.

5. The method of claim **1**, further comprising:

advancing a centering shaft into and extending from said articular surface along said first working axis;

measuring a plurality of points from a fixed position along said centering shaft to said articular surface, said plurality of point indicative of a curvature of said articular surface in at least one plane; and

selecting, based on said plurality of points, an implant having a bone-facing surface and a load-bearing surface that substantially matches said curvature of said articular surface.

6. The method of claim **5**, further comprising:

selecting a guide block having a curvature based on said plurality of points;

advancing said guide block to said articular surface about said first working axis, said guide block comprising at least two opposing points configured to contact said articular surface at different locations and first and second bores therein defining the location of said first and second working axes with respect to said articular surface.

7. The method of claim **5**, further comprising:

advancing a sizing trial implant into, at least in part, said first and second sockets, said sizing trial implant having a curvature of at least one surface thereof based on said plurality of points; and

confirming that said sizing trial implant fits within said first and second sockets.

8. The method of claim **1**, further comprising:

advancing a first and a second guide pin into said articular surface along said first and second working axes, respectively.

9. The method of claim **8**, further comprising:

advancing a cannulated contact probe over said first guide pin to determine at least one depth measurement in at least one plane, said contact probe comprising an outrigger extending radially from a cannulated shaft.

10. The method of claim **9**, further comprising:

advancing a cannulated drill guide to contact said articular surface, said cannulated drill guide comprising a cannulated handle and a first arcuate tip section removably coupled to a distal end of said cannulated handle, said first arcuate tip section comprising first and second bone contacting points and a bore aligned with a lumen of said cannulated handle, wherein said first guide pin is advanced through said bore and said lumen to establish said first working axis.

11. The method of claim **10**, further comprising:

removably coupling a guide block onto said distal end of said cannulated handle, said guide block comprising a body portion having a curvature based on at least one said depth measurement, first and second bone contacting points, a first bore aligned with a lumen of said cannulated handle, and a second bore spaced apart from said first bore, said second bore defining said second working axis;

advancing said guide block and cannulated handle over said first guide pin; and installing a second guide pin into said articular surface through said second bore and along said second working axis.

12. The method of claim 11, further comprising:

removably coupling a cannulated bushing into said second bore prior to installing said second guide pin.

13. The method of claim 8, further comprising:

advancing a first and a second reamer over said first and said second guide pin, respectively; and

rotating said first and said second reamer about said first and said second guide pin to create said first and said second socket.

14. The method of claim 11, further comprising:

advancing a cannulated tap over said first guide pin and into said articular surface to tap area of bone surrounding said first guide pin;

advancing a tapered post over said first guide pin into the tapped area of bone to secure said tapered post into said bone.

15. The method of claim 14, further comprising:

selecting an implant comprising a load-bearing surface that substantially matches said curvature of said articular surface and having a curvature based on at least one said depth measurement, said implant is dimensioned to fit within, at least, said first and second sockets, said implant also comprising a bone-facing surface comprising a recess configured to mate with the taper of said tapered post;

installing said implant into said first and second sockets by mating said recess with said tapered post.

16. The method of claim 15, further comprising:

applying adhesive to said bone-facing surface prior to said installing said implant.

17. A method for preparing an implant site, comprising:

advancing a first guide pin into said bone to establish a first working axis extending from an articular surface;

advancing a second guide pin into said articular surface to establish a second working axis extending from said articular surface;

advancing a first reamer over said first guide pinto form a first socket extending through said articular surface and partially into said bone; and

advancing a second reamer over said second guide pinto form a second socket in said extending through said articular surface and partially into said bone;

wherein said first and said second sockets partially overlap with and extend beyond each other.

18. The method of claim 17, wherein said first and said second working axes are established by placing a guide block onto the surface of the articular surface such that at least two opposing points of the guide blocks contact said articular surface, said guide block having first and second bores therein defining the location of said first and second working axes with respect to said articular surface.

19. The method of claim 17, further comprising:

advancing a third guide pin into said articular surface to establish a third working axis extending from said articular surface;

advancing a third reamer over said third guide pine to form a third socket through said articular surface and partially into said bone;

wherein said second socket partially overlaps with said first socket and said third socket.

20. The method of claim 17, wherein said first and said second reamer have different cutting diameters.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,055,955 B2
APPLICATION NO. : 13/037929
DATED : June 16, 2015
INVENTOR(S) : Steven W. Ek et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims

In column 14, line 7, in Claim 17, delete "pinto" and insert -- pin to --, therefore.

In column 14, line 10, in Claim 17, delete "pinto" and insert -- pin to --, therefore.

In column 14, line 26, in Claim 19, delete "pine" and insert -- pin --, therefore.

Signed and Sealed this
Seventeenth Day of November, 2015

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office